Mycorrhizal Symbioses With Jelutung (Dyera Lowii Hook) Under Increasing Phosphate Rock Levels In Peat Soil

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Abstract: Study the mycorrhizal symbioses with *Dyera lowii* Hook (jelutung) under increasing phosphate rock levels in the peat soils was conducted in a greenhouse laboratory Universeitas Soil Science Faculty of Agriculture Gadjah Mada University for 5 months in 2010. Research purposes to determine the dosage of phosphate rock fertilizers that can enhance the growth of *D.lowii* seedlings inoculated with mycorrhizal fungi arbuskula. Nursery experiments using Completely Randomized Factorial Design with three replications. Observations made on *D.lowii* seedlings 14 weeks of age after weaning include: height, diameter, number of leaves, and to shoot dry weight, P uptake of plants after harvest. Trials testing dosage of phosphate rock fertilizers in *D.lowii* inoculated with mycorrhizal fungi arbuskula prove that phosphate rock fertilizer dosage of 100 ppm is the best enhance the growth of *D.lowii* seedlings in the nursery.

Keywords: *Peatland, mycorrhizal, jelutung and phosphate rock*

Rehabilitation of degraded peatswamp forest in the form of reforestation activities, which often have serious obstacles due to unfavorable soil conditions. Peat soil reacts sourly (low pH), scarcity of food nutrients, especially phosphate (P) and nitrogen (N). That condition is a major obstacle for the growth of forest plants and reforestation success. Newly planted seedlings in the field are often slow-growing, languish and die. Efforts in helping the growth of forest plants and enhance the vitality of seedlings in degraded peat lands are, in addition to appropriate silvicultural techniques are required and the selection of suitable trees, also required high energy input and expensive, such as liming, and fertilizing complete. In the framework of environmentally sound forest development, the application of technology in the form of soil microbial utilization of biological fertilizers (biofertilizer) of inoculum AMF is one of the alternative strategies is not only effective but cheaper and more environmentally.

AMF utilization on forest plants is very potential, given in planting in the field, forest plant nurseries require a phase before being transferred to the field. The quality and appearance of seedlings in the nursery will determine the development of tree crop growth later on in the field. Seeds with good quality to have a good correlation also with the increment of growth in the future.

Forest plants that have been known to associate with the AMF is *Tectona grandis* and *Gmelina arborea* Roxb (Mardatin, 2002), *Paraseriantes falcataria* , *Accasia*, and *Eucalyptus* (Setiadi, 1993), *Gonystilus bancanus* (Muin, 2003), *Vitex* *bubescen* Vahl (Prayudyaningsih & Santoso, 2007), with the AMF and utilization techniques of various types of inoculum.

According to Laura *et al*., (2008) AMF inoculation can improve jelutung seedling growth in peat soil. Further Turjaman *et al*., (2008) describes the results of research on peat for *Shorea balangeran* and *Calophyllum Hosei*, inoculation with ectomicorrhizal can increase height growth, stem diameter, and dry weight of plants. Likewise *Dyera polyphylla* and *Alstonia scholaris*, inokulsi with AMF can increase height growth, stem diameter and dry weight of plants compared with plants without AMF inoculation.

Jelutung (*Dyera lowii* Hook) including Apocynaceae tribe known as the Labuwai, Melabuwai (Sumatra), jelutung (West Kalimantan), jelutung and Pantung (Central and East Kalimantan), while the name in another State; petroleum (Malaysia) and Jelutong (UK) (Heyne, 1987). *D. lowii* wood is soft and white with a textured surface is rather flat, smooth and slippery so that it can be used as a shoe pattern, as raw material for the manufacture of pencils and as materials for boards and crates. Wood veneer *D. lowii* easily made and easily glued. *D. lowii* easily sawn wood is dry and easy to work as planed, drilled, nailed, screwed and finishing such as paint, varnish and polished. All parts of fresh wood is very susceptible to attack blue-stain fungus. Peeling skin without fungicides will facilitate the granting matched the blue-stain attack (Heyne, 1987).

D. lowii belongs to the dual-purpose tree species, meaning that trees can produce both types of commodities namely commodity forest products Non-Wood Forest Products (NWFPs) in the form of sap *D. lowii* and forest timber in the form of commodities. The above indicates that the tree *D. lowii* including dual-purpose tree species, it is good to be developed in the buffer zone as an enhancer of plant conservation and sources of income for local communities. *D. lowii* crop development efforts in the buffer zone needs to be coupled with counseling on tapping techniques, processing and quality standards *D. lowii* commodities, so that local people can enjoy the added value of processing the sap *D. lowii* (Heyne, 1987).

Indonesia is a major producer of *D. lowii* latex, almost the entire production of *D. lowii* gum Indonesia exported abroad in the form of chunks. Export destinations include Singapore, Japan and Hong Kong. *D. lowii* sap serves as a raw material for making chewing gum which began in the 1920s and the 1940s have shifted the position of the sap *D. lowii* latex from the tree *Achras sapota*, the original raw material-producing tree gum originating from Central America. *D. lowii* sap is also used in industrial adhesives, shellac, lanolic, varnish, tires, water proofing and paint as well as insulating materials and handicrafts.

Phosphate rock is a fertilizer plant material. Based on their chemical composition, phosphate rock is classified as a calcium phosphate (Ca-P), calcium-aluminum (iron) phosphate (Ca, Al (Fe)-P), and aluminum (iron) phosphate (Al (Fe)-P). Calcium phosphate is the main raw ingredient superphosphate fertilizer. Calcium-aluminum (iron) phosphate is commonly used in fertilizer industries NP, NPK or used directly as fertilizer P (Sediyarso, 1999).

Phosphate rock is a source of P that is slow release and solubility will be higher with increasing soil acidity. According to Pandi and Mario (2000), the main mineral found in phosphate rock is apatite (usually in the form of flour and calcium phosphate) that are not soluble and stable in neutral or alkaline. In acidic peat soil conditions, the solubility of phosphate rock will be high. Further explained phosphate rocks also contain other follow-up of macro and micro nutrients such as Ca, Mg, Fe, Cu, Zn, and Co the availability in peat soils is relatively low.

Chemical properties of peat used in the experiment reacted very acidic (pH = 2.51) with very high organic C content (31.14%), total N content in the criteria is very high (0.91%), available P (Bray 1) including the criteria is very low (21 ppm). Cations that can be interchanged as being classified as K + (0.40 C mol (+). Kg-1), Mg + with a high criterion (2.6 C mol (+). Kg-1), Ca +2 is low (2.23 C mol (+). kg-1), cation exchange capacity with the criteria of very high (64.00 C mol (+). kg-1), and base saturation is very low (8.2%) (Burhanuddin, 2011).

MATERIALS AND METHODS

This study used pure experiments with factorial treatment design arranged in Completely Randomized Design. Experimental treatments consisted of: a). Mycorrhizal inoculation with *Glomus* sp types of AMF: ((-) M = without inoculation AMF and (+) M = inoculated with AMF), b). Types of trees: (J = jelutung (*D.lowii* Hook), c). Dosage of phosphate rock fertilizers: (RF_0 = 0 ppm (control), RF_1 = 25 ppm, 50 ppm = RF_2, RF_3 = 75 ppm, 100 ppm = RF_4, RF_5 = 125 ppm, RF_6 = 150 ppm). Each treatment was inoculated with one type of AMF and the control without inoculation. Each treatment combination was repeated 3 times, then the total number of treatment combinations are: 2 x 1 x 7 x 3 = 42.

This study uses a pure experimental method to: (1) saw the causal effect of dosage of phosphate rock fertilization on the growth of *D. lowii* the inoculated with *Glomus* sp , (2) use of control seedlings grown without AMF inoculation with a dosage of phosphate rock fertilizers; 0 ppm, 25 ppm, 50 ppm, 75 ppm, 100 ppm, 125 ppm and 150 ppm.

Seeds of *D. lowii* were the surface sterilized in 70 % alcohol for 5 min, subsequently rinsed with sterilized water and germinated on sterilized peat soils. Four week old uniform seedlings were transplanted into plastic pots (18 x 20 cm) containing 1,0 kg. Phosphate rock fertilizer are given prior to planting with a dosage of 0 ppm, 25 ppm, 50 ppm, 75 ppm, 100 ppm, 125 ppm and 150 ppm. Subsequently seedlings were planted in polybag of sterile peat media has been filled and given basal fertilizer solution in the given form of a solution consisting of 70 ppm NH4NO3, KH2PO4 35 ppm, 70 ppm K2SO4, 70 ppm CaCl 2, 22 ppm CuSO4.5H2O , ZnSO4.7H2O 5 ppm, 10 ppm MnSO4.7H2O, CoSO4.7H2O 0.33 ppm, 0.20 ppm NaMoO4.2H2O, and 20 ppm MgSO4.7H2O (Pearson *et al*., 1994). Plants inoculated with the AMF as much as 10 g / polybag with a spore density of 100-200 spores per 10 grams. AMF control plants not inoculated. During plant growth, soil humidity was maintained at field capacity. Plants were grown for 14 weeks after weaning in the greenhouse Laboratory of

Soil Science Faculty of Agriculture, University of Gadjah Mada. Data collected consisted of height (cm), stem diameter (mm), number of leaves (blade), shoot dry weight (g / plant), and P uptake of plant nutrients. Data high, diameter, leaf number, dry weight of plant shoots and plant uptake of P was analyzed by analysis of variance (ANOVA) completely randomized design using SAS methods X3.

RESULTS

Plant height

The treatment of rock phosphate fertilization and inoculation with *Glomus* sp did not show significantly different to the high increase in *D. lowii* seedling age of 14 weeks after weaning (Figure 1) compared with dosages of phosphate rock fertilizers are the same regardless of inoculation with *Glomus* sp. At the age of *D. lowii* seedlings 14 weeks after weaning showed that the inoculation treatment of *Glomus* sp at doses of rock phosphate fertilizer 0 ppm can spur the growth of *D. lowii* seedlings same height with rock phosphate fertilization treatment at doses of 50 ppm without inoculation with *Glomus* sp.

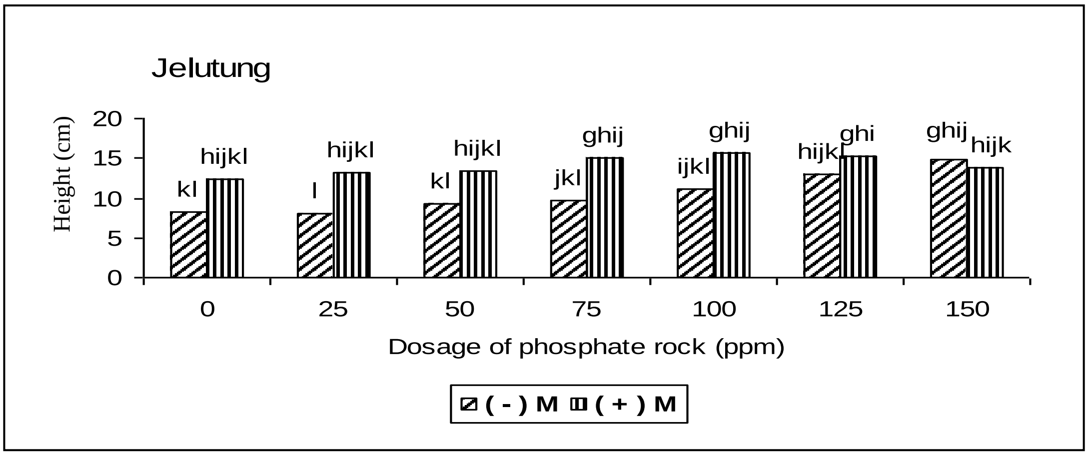


Figure 1. Effect of dosage of phosphate rock fertilizers and AMF inoculation to *D. lowii* shoot height at 14 weeks after weaning.
Description: The same letter in the histogram are not significantly different based on Duncan's multiple range test level of 5 percent.

Stem diameter

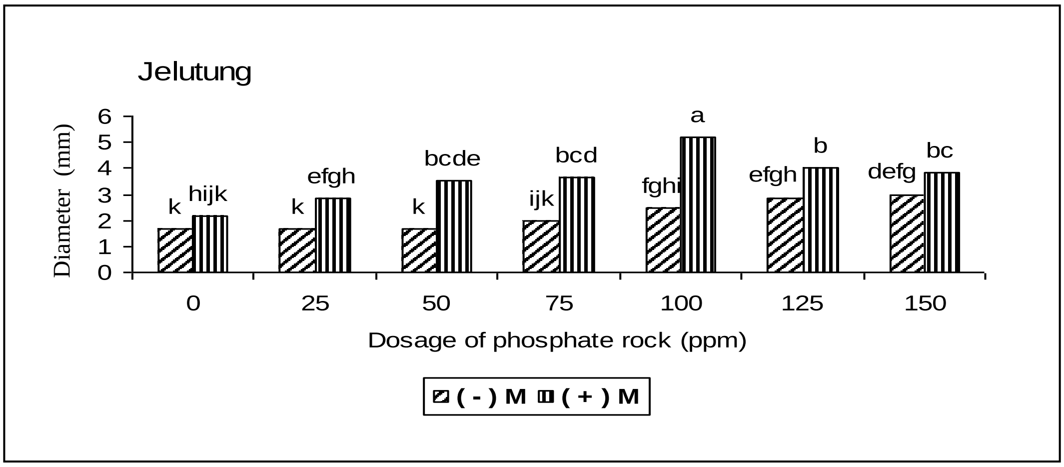


Figure 2. Effect of dosage of phosphate rock fertilizers and AMF inoculation to *D. lowii* stem diameter at 14 weeks after weaning. Description: The same letter in the histogram are not significantly different based on Duncan's multiple range test level of 5 percent.

The treatment of phosphate rock fertilization and inoculation with *Glomus* sp was significantly different to the stem diameter of the *D. lowii* seedling age of 14 weeks after weaning (Figure 2) compared with dosages of phosphate rock fertilizers are the same regardless of inoculation with *Glomus* sp. *D. lowii* seedlings at each dose of fertilizer 150 ppm 125 ppm, 25 ppm, 75 ppm, 100 ppm and 50 ppm increases the stem diameter of seedlings in a row by 35.33%, 60 00%, 70.48%, 83.00% , 106.40% and 110.84% compared with a dosage of phosphate rock fertilizers are the same regardless of inoculation with *Glomus* sp. At the age of *D. lowii* seedlings 14 weeks after weaning showed that the inoculation treatment of *Glomus* sp at dosages of phosphate rock fertilizer 0 ppm can spur the growth of *D. lowii* seedlings stem diameter equivalent to phosphate rock fertilization treatment at dosages of 75 ppm without inoculation with *Glomus* sp.

Number of leaves

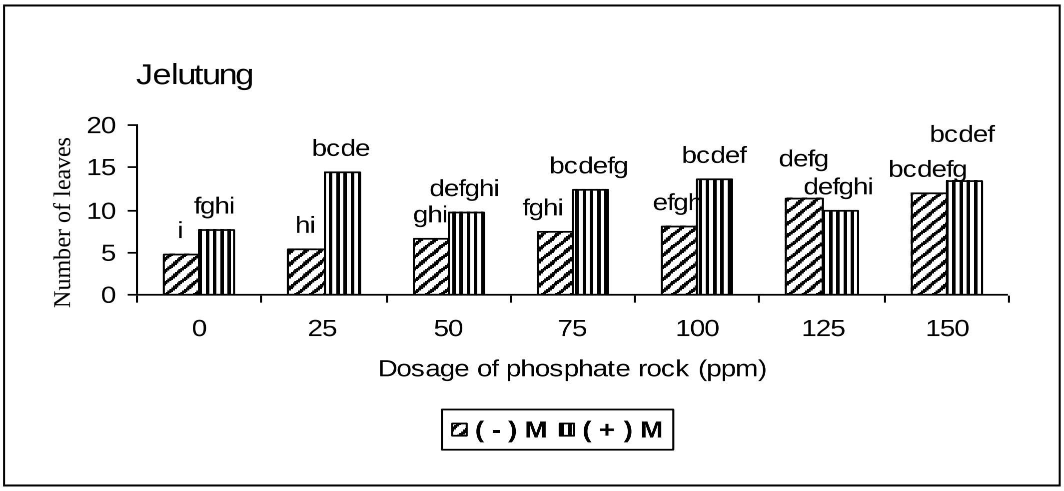
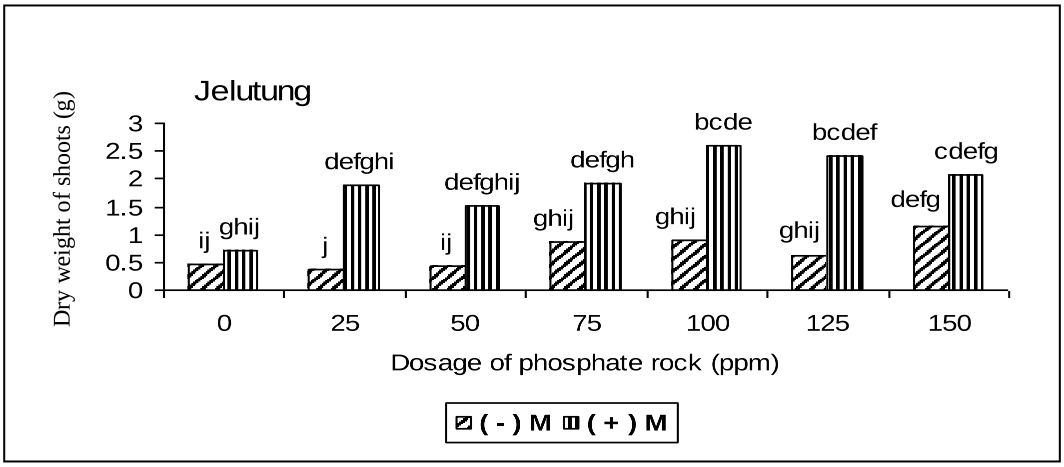


Figure 3. Effect of dosage of phosphate rock fertilizers and AMF inoculation to *D. lowii* number of leaves at 14 weeks after weaning. Description: The same letter in the histogram are not significantly different based on Duncan's multiple range test level of 5 percent.

The treatment of phosphate rock fertilization and inoculation with *Glomus* sp was significantly different to the number of leaves *D. lowii* seedling leaves age of 14 weeks after weaning (Figure 3) compared with dosages of phosphate rock fertilizers are the same regardless of inoculation with *Glomus* sp. *D. lowii* on fertilizer dosage of 25 ppm increases the number of leaves of 168.85% compared with a dosage of phosphate rock fertilizers the same without inoculation AMF. At the age of seedlings 14 weeks after weaning showed that the inoculation treatment of *Glomus* sp at dosages of phosphate rock fertilizer 0 ppm can spur growth in the number of leaves *D. lowii* seedling equivalent of phosphate rock fertilization treatment at dosages of 75 ppm without inoculation with *Glomus* sp.

Dry weight of shoots.

Differences response *D. lowii* seedling shoot dry weight of each dosage of phosphate rock fertilizers at 14 weeks after weaning are presented in Figure 4. The treatment of phosphate rock fertilization and inoculation with *Glomus* sp was significantly different to the shoots dry weight of plant *D. lowii* compared with a dosage of phosphate rock fertilizers are the same regardless of inoculation with *Glomus* sp.



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D. lowii at dosages of fertilizer each 100 ppm, 125 ppm and 25 ppm increased shoots dry weight of plant in a row by 188.89%, 280.95% and 427.78% compared with a dosage of phosphate rock fertilizers are the same regardless inoculation with *Glomus* sp. At the age of seedlings 14 weeks after weaning showed that the inoculation treatment of *Glomus* sp at dosages of 0 ppm phosphate rock fertilizer can increase shoots dry weight of plant *D. lowii* with phosphate rock fertilization treatment at dosages of 75 ppm without inoculation with *Glomus* sp.

P uptake of plants

P uptake response differences *D. lowii* seedlings of each dosage of phosphate rock fertilizers at 14 weeks are presented in Figure 5. The treatment of phosphate rock fertilization and inoculation with *Glomus* sp different real impact on *D. lowii* seedling P uptake compared with phosphate rock fertilizer dosage of the same without inoculation with *Glomus* sp. *D. lowii* on fertilizer dosage of 100 ppm and 125 ppm increase P uptake by seedlings were 266.54% and 313.72% compared with a dosage of phosphate rock fertilizers are the same regardless of inoculation with *Glomus* sp. *D. lowii* seedlings treatment with *Glomus* sp inoculation treatment at dosages of 0 ppm phosphate rock fertilizer can increase plant P uptake with phosphate rock fertilization treatment at dosages of 100 ppm without inoculation with *Glomus* sp.

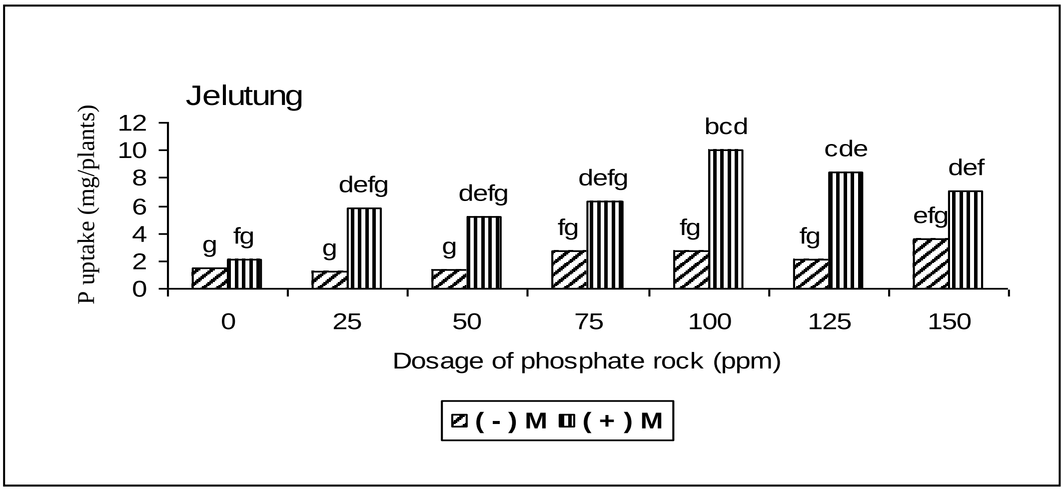

Figure 5. Effect of dosage of phosphate rock fertilizers and AMF inoculation to *D. lowii* P uptake at 14 weeks after weaning. Description: The same letter in the histogram are not significantly different based on Duncan's multiple range test level of 5 percent.

DISCUSSION

In Figure 1 shows that administration of phosphate rock to increase the role in spurring the growth of *D. lowii* seedlings with AMF inoculation. Without the provision of phosphate rock , high *D. lowii* seedling only 12.33 cm. Providing phosphate rock fertilizer can increase as much as 25 ppm to 13.17 cm plant height. Optimal dosage of phosphate rock fertilizers that can be given to *D. lowii* seedlings that colonized AMF was 100 ppm. At dosages of 100 ppm which is the largest high 15.77 cm. Provide fertilizer phosphate rock as much as 150 ppm, high-growth *D. lowii* seedlings colonized the AMF started to decline. At higher dosages of 150 ppm for *D. lowii* seedlings only 13.77 cm. Inoculation with the AMF in *D. lowii* seedlings showed high growth is better than without AMF inoculation. This result coincides with findings Muin (2003), that the *Gonystilus bancanus* plants are inoculated with AMF, if fertilized with natural phosphate chrismast much as 0.50 g / polybag can enhance growth of 209.97% higher compared to plants without inoculation with AMF.

In Figure 2 shows that administration can enhance the role of phosphate rock in the JMA spur *D. lowii* seedling diameter growth. Without the provision of phosphate rock, the diameter of colonized *D. lowii* seedlings AMF only 2.17 mm. Provision of phosphate rock fertilizer as much as 25 ppm can increase the stem diameter of the *D. lowii* seedling to 2.83 mm. Optimal dosage of phosphate rock fertilizers that can be given to *D. lowii* seedlings that colonized AMF was 100 ppm. At dosages of 100 ppm largest stem diameter growth that is 5.17 mm. Provide fertilizer phosphate rock as much as 150 ppm, stem diameter growth of *D. lowii* seedlings colonized AMF decreased. At dosages of 150 ppm *D. lowii* seedling stem diameter only 3.83 mm. Inoculation with the AMF in *D. lowii* seedling stem diameter showed better growth compared with no inoculation AMF. This result coincides with findings Muin (2003), that the plants *Gonystilus bancanus* are inoculated with AMF, if fertilized with natural phosphate chrismast much as 0.50 g / polybag can increase stem diameter growth of 291.67% compared with plants without inoculation with AMF.

In Figure 3 it is seen that the provision could increase the role of phosphate rock in the AMF spur *D. lowii* seedling growth. Without the provision of phosphate rock, the number of leaves of *D. lowii* seedlings that colonized AMF only 7.67 strands. Provide fertilizer phosphate rock as much as 25 ppm can increase the amount of plant leaves into strands 9.67. Optimal dosage of phosphate rock fertilizers that can be given to *D. lowii* seedlings that colonized AMF was 100 ppm. At dosages of 100 ppm which is the largest growth in the number of leaf blade 13.67. Provision of phosphate rock fertilizer as much as 150 ppm, growth in the number of leaves colonized *D. lowii* AMF decreased. At dosages of 150 ppm the amount of leaf blade *D. lowii* only 12.33.

In Figure 4 it is seen that the provision could increase the role of phosphate rock in the AMF spur the growth of *D. lowii* seedlings. Without the provision of phosphate rock, dry weight of shoots of the *D. lowii* seedlings that colonized AMF only 0.70 grams. Providing phosphate rock fertilizer can increase as much as 25 ppm dry weight of shoots to be 1.90 grams. Optimal dosage of phosphate rock fertilizers that can be given to *D. lowii* seedlings that colonized AMF was 100 ppm. At dosages of 100 ppm is the largest shoots dry weight 2.40 grams. Provision of phosphate rock fertilizer as much as 150 ppm, dry weight puck on a colonized *D. lowii* seedlings AM started to decline. At dosages of 150 ppm shoots dry weight of *D. lowii* seedling only 2.07 grams. The results prove that the phosphate rock fertilizer dosage of 100 ppm can increase shoots dry weight of *D. lowii*. According to Mendoza *et al*., (2009), *Lotus tenuis* plants increased shoots dry weight at dosages of phosphate rock fertilizers 100 ppm, although there was an increase in dosage above 100 ppm. This result coincides with findings Muin (2003), that the *Gonystilus bancanus* are inoculated with AMF, if fertilized with natural phosphate chrismast much as 0.50 g / polybag plant dry weight can increase by 226.21% compared with plants without inoculation with AMF.

In Figure 5 it is seen that the provision could increase the role of phosphate rock in the AMF spur the growth of *D. lowii* seedlings. Without the provision of phosphate rock, P absorbed by the *D. lowii* seedlings that colonized AMF only 2.05 mg. Provide fertilizer phosphate rock as much as 25 ppm can enhance the uptake of 5.79 mg P. Optimal fertilizer dosage of phosphate rock fertilizers that can be given to *D. lowii* seedlings that colonized AMF was 100 ppm. At dosages of 100 ppm P element that is absorbed at most 9.97 mg. Provide fertilizer phosphate rock as much as 150 ppm, the absorption of P by *D. lowii* seedlings colonized the AMF started to decrease up to 7.11 mg.

In these conditions of AMF in the *D. lowii* roots become more involved in the absorption of nutrients P from phosphate rock. According to Gunawan (1993) in some circumstances, growth and P content of phosphate rock fertilized plants increased of mycorrhizae, although only on the provision of phosphate rock with a high dosage. In acidic soils such as peat moss if phosphate rock is given in excessive dosages, cause the role of the AMF to be reduced, because most of the soluble P that can be utilized by the roots without the aid of AMF. Phosphate rock is a source of P that is slow release and solubility of its P will be higher with increasing soil acidity. This is according to Pandi & Morio (2000) caused major mineral found in phosphate rock is apatite, which is usually in the form of flour and calcium phosphate is insoluble or unstable in neutral or alkaline, so that in acidic conditions such as peat soil phosphate solubility nature will high. Noting the value of P uptake *D. lowii* seedlings mentioned above, it was phosphate rock can increase the growth of *D. lowii* seedlings inoculated with AMF. Provide as much as 25 ppm of phosphate rock has not been enough to boost growth and provision of rock phosphate *D. lowii* more than 100 ppm lead *D. lowii* decreased seedling growth. Nevertheless, *D.lowii* seedling growth is still higher than *D. lowii* seedlings colonized AMF is not fertilized with phosphate rock. Increased seedling growth as a result of increased *D. lowii* AMF role in the use of nutrients (especially P) contained in phosphate rock. Based on the results of these experiments, it can be concluded that the phosphate rock can be used to enhance the growth of *D. lowii* seedlings in the nursery. The results are consistent with the results presented Mendoza *et al*., (2009) *Lotus tenuis* plants increased P content in shoot tissue at dosages of phosphate rock fertilizers 100 ppm, and decreased P content in shoot tissue at dosages above 100 ppm.

CONCLUSION

In the experimental test results of phosphate rock fertilizer dosage in the inoculated *D. lowii* seedlings AMF type *Glomus* sp proves that the 100 ppm dosage of fertilizer is best, followed by dosages of 125 ppm fertilizer *D. lowii* spur the growth of seedlings.

SUGGESTION

Generally it can be suggested that the AMF type *Glomus* sp combined with the provision of phosphate rock fertilizer dosage of 100 ppm can be used broadly *improve D. lowii* seedling on peat soil in the nursery.

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