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Artikel

The Effect of Mychorrizha Enriched Seed Encapsulation to Soybean Growth and Yield

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ABSTRACT

The high number of soybean's import has led to various efforts to increase soybean production through increasing productivity, expanding planting areas, and improving management. One that can be done in maximizing soybean performance is the application of biological fertilizer such as mycorrhiza because it was able to increase nutrien tuptake and water and even drought tolerance. This study aims to determine the effect of encapsulation of soybean seeds enriched with mycorrhiza and explain the effect of mycorrhiza on soybean growth and yield. This study used three soybean varieties namely Anjasmoro, Grobogan, and Argomulyo which treated with encapsulation + mycorrhiza, mycorrhiza addition, and without mycorrhiza. The observation include number of pods per plant, number of seeds per plant, percentage of filled pods per plant, seed weight per plant and weight of 100 seeds. Data on seed weight per plant showed significantly different among varieties and Anjasmoro was the highest. The application of mycorrhiza through seed encapsulation did not improve the soybean performance.

Keywords: soybean, mycorrhiza, encapsulation

BACKGROUND

Soybean processed products such as tempeh, tofu, soy sauce, chips and other are very popular among Indonesian citizens. Every 100 g of soybean seeds contains 330 calories, 35% protein, 18% fat, 35% carbohydrate, 10% water, and some minerals such as Ca, Fe, vitamin A and vitamin B1 (Pato dan Yusmarini, 2002). The content of phenolic compounds and unsaturated fatty acids contained in soybean seeds is also known to be efficacious as a cancer prevention and coronary heart disease (Rukmana dan Yuniarsih, 2004).

National demand for soybeans is quite high. This can be seen from National Statistics Office in 2015 which shows that the consumption of tempeh per capita per year in Indonesia were 6.99 kg and tofu 7.51 kg. Ironically, the fulfillment of soybeans demand, the main raw material for tempeh and tofu, around 67.28% (1.96 million tons) must be imported, because domestic production is unable to meet domestic demand (Anonim, 2016). The high number of imports encourage various efforts to increase soybean production, namely to increase productivity, expand planting areas, and improve management.

In Indonesia, soybeans are identical as dry land plant with low fertility so that growth is unoptimal, whereas, new cultivars have greater nutrient requirements. Land conditions that are often found in Indonesia in the form of soil with high organic matter, but nutrients are not available for plants, such as phosphate elements. Most forms of phosphate are bound by colloidal soils. High-dose phosphate fertilization can cause an increase in soil residue and plant phosphate deficiency. To anticipate this, biological fertilizer can be used, namely mycorrhiza. Mycorrhizal fungi are known to increase nutrient uptake and water and increase plant resistance to drought (Simanungkalit, 1993).

Mycorrhiza should be given through seeds, but unfortunately mycorrhiza cannot be attached directly to seeds so they need additional adhesive (Permanasari *et al.*, 2016). The material that can be used in attaching mycorriza to seeds is encapsulation using clay minerals such as montmorillonite. This kind of clay mineral is often used as a carrier material with immobilization and adsorption techniques to increase the effectiveness of using several microorganisms for biological fertilizer.

MATERIALS AND METHODS

The experiment was carried out in a research field of Agrotechnology Innovation Centre, Kalitirto, Berbah, Sleman, Yogyakarta in August until October 2018. The materials used were, mycorrhizal, montmorillonite, cultivar soybean seeds i.e. Anjasmoro, Argomulyo, Grobogan, molasses, fertilizers, and insecticides. The tools needed were scales, tubs, filters, stationery, hoes, sickles, ruler, and buckets.

The study were used a Split Plot Design. The main plot (main plot) were soybean cultivars consisting of three levels, Anjasmoro, Argomulyo, and Grobogan. Subplot were an encapsulation treatments consist of three levels, without the application of mycorrhiza, with mycorrhiza application but without encapsulation, and with application of mycorrhiza and encapsulated with montmorillonite. The total of nine combinations repeated three times.

Soybean seed planting in the treatment without mycorrhiza is done conventionally. In mycorrhizal treatment without encapsulation, mycorrhiza and molasses are mixed with seeds before planting. Mycorrhizal treated with montmorillonite encapsulation was done by wrapping 500 g of seed with 100 g of montmorillonite, 50 g of mycorrhiza, and 10 mL of molasses. Observations were made on the growth and yield components.

RESULTS

Plant growth is a result of the metabolism of living cells which can be measured quantitatively. Plant height is related to nutrient and water uptake and the ability of photosynthesis. The absorption of water and nutrients by the roots will be passed into the leaves for use as photosynthetic material (Muhammad, et al., 2000).

In the absence of mycorrhiza, the highest result was shown by the Anjasmoro, followed by the Argomulyo cultivar, and the last Grobogan cultivar. In the treatment of mycorrhiza without encapsulation, Anjasmoro cultivars had the highest plant height, while the Argomulyo and Grobogan cultivars had almost the same plant height. In the treatment of mycorrhizal with montmorillonite encapsulation, the highest plant was shown by Anjasmoro cultivar, then Argomulyo cultivar and finally was Grobogan cultivar.

Based on Table 1, the real difference is only shown in two variables, the number of pods per plant and seeds per plant. The number of pods per plant showed significant differences in the cultivars, whereas in the seed number per plant, the interaction between varieties with treatments showed significantly different.

Table 1. The result of ANOVA analysis

Source	P-Value					
	Pod number per plant	Seed number per plant	Percentage of filled pods per plant	Seeds weight per plant	100 seeds weight	Seeds weight per hectare
Variety	0,0003*	0,178	0.9191	0,3604	0,7758	0.2806
Treatment	0,1323	0,2333	0.3912	0,4037	0,6149	0.5869
Variety*Treatment	0,1858	0,0487*	0.3958	0,3668	0,9901	0.9218

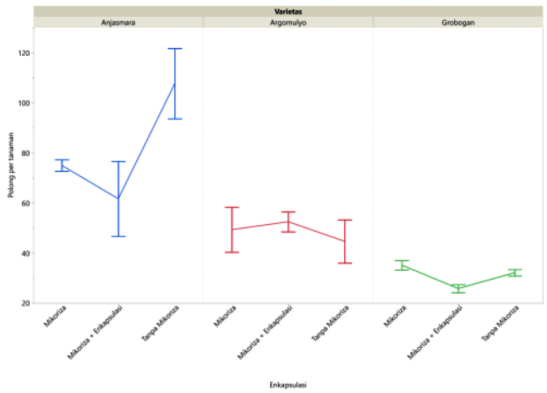

Figure 1. The number of pods per plant of 3 soybean varieties treated with mycorrhiza

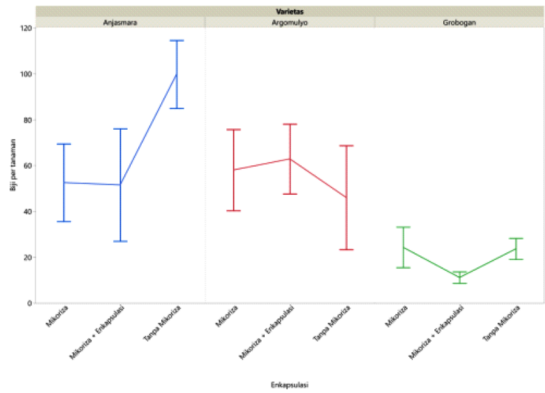

Figure 2. The number of seeds per plant of 3 soybean varieties treated with mycorrhiza

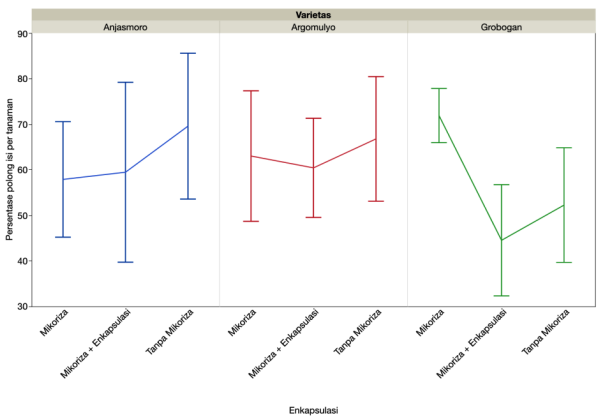

Figure 3. The perceentage of filled pods per plant of 3 soybean varieties treated with mycorrhiza

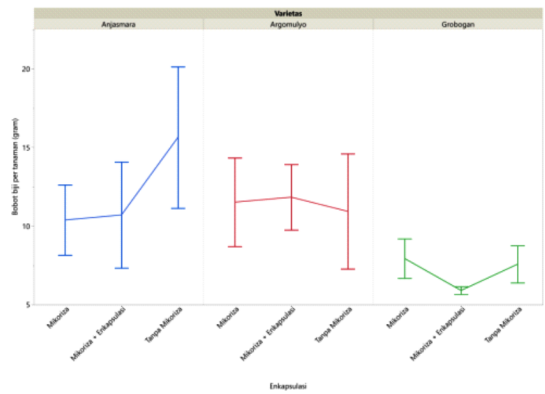

Figure 4.. The weight of seeds per plant of 3 soybean varieties treated with mycorrhiza

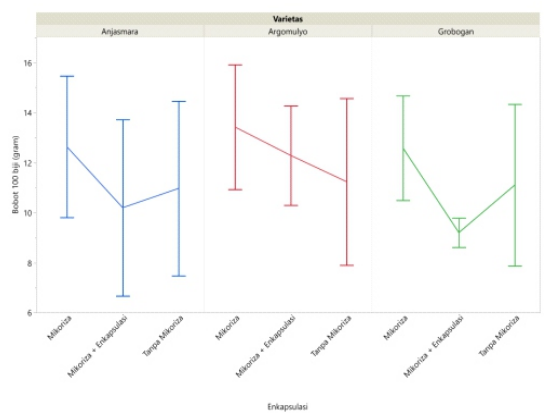

Figure 5. The 100 seeds weight of 3 soybean varieties treated with mycorrhiza

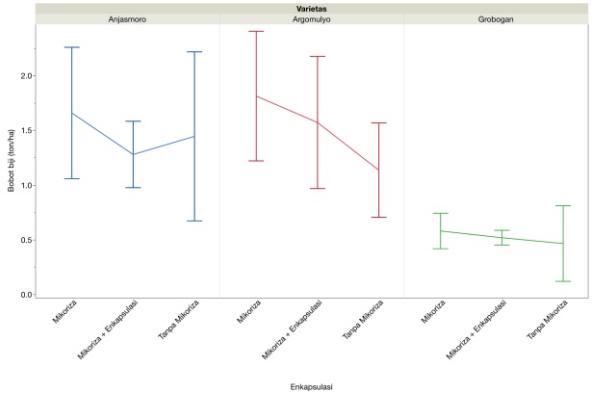

Figure 6. The seeds weight per hectare of 3 soybean va rieties treated with mycorrhiza

The number of Pods per Plant

Figure 4 shows that in the Anjasmoro variety, without mycorrhiza treatment showed significantly different results compared to the other two treatments. The highest average was also shown in the treatment without mycorrhiza with a mean planting pods of 107.7. The other two treatments, with mycorrhiza and mycorrhiza + encapsulation did not show any significant difference. In the Argomulyo variety, none of the three treatments showed significant differences. Grobogan variety showed significant different between the three treatments with the highest yield found in mycorrhizal treatment which had an average pods of 35.2 per plant and the lowest in mycorrhizal + encapsulation treatment with 25.8 pods.

The number of Seeds per Plant

Based on Table 1, the number of seeds per plant variable showed a significant interaction between the treatment and the tested varieties. In Figure 2 when all graphs are compared together, Anjasmoro variety have the highest results in the treatment without mycorrhiza. The number of seeds per plant formed was 99.7. The results on Anjasmoro variety with mycorrhiza + encapsulation treatment and with mycorrhiza showed no significant difference. Argomulyo variety in all treatments also showed no real difference. In Grobogan variety, mycorrhiza + encapsulation treatment showed significantly different results with the lowest seed yield per plant which was 11.2.

Percentage of Filled Pods per Plant

ANOVA test results on the variable percentage of pods per plant showed no significant difference in the interaction between treatments with the tested variables. Figure 3 shows that in Anjasmoro variety, there was no significant difference between all treatments tested. In Argomulyo variety, there was no significant difference between treatments, while in Grobogan variety there was a real difference between the treatment with mycorrhiza with mycorrhiza + encapsulation treatment and without mycorrhiza.

Seeds Weight per Plant

The results of ANOVA test on the weight of seeds per plant showed no significant difference in the interaction between encapsulation treatment with the variety. Figure 4 shows that in Anjasmoro variety, the treatment without mycorrhiza is significantly different from the treatment of mycorrhiza + encapsulation and treatment with mycorrhiza. Treatment without

mycorrhiza showed the highest results with an average weight of seeds per plant of 99.7 grams. Mycorrhiza treatment and mycorrhiza + encapsulation treatment did not show any significant difference. In Argomulyo variety all treatments showed there were not significantly different. In Grobogan varieties, mycorrhizal + encapsulation treatment showed significantly different results with treatment without mycorrhiza and with mycorrhiza.

100 Seeds Weight

Anova test results on the 100 seeds weight variable showed no significant difference in the interaction between the encapsulation treatment and the variety used. In Figure 5, the only significant difference was shown in Grobogan variety between mycorrhiza + encapsulation with without mycorrhiza treatment and with mycorrhiza at 100 seed weight variables. In all treatments in Grobogan variety, mycorrhizal + encapsulation treatment showed the lowest results, which was 9.2.

Seeds Weight per Hectare

The variable weight of seeds per hectare in the ANOVA test did not show any significant difference in the interactions between the varieties tested and the treatments given. The results in Figure 6 shows that in Anjasmoro variety, there was no significant difference between all treatments tested. The same thing happened to Argomulyo variety which did not show any real difference in all treatments tested. Grobogan variety on this variable also did not show any real difference in all treatments tested.

Soybean is a type of legumes which has very good potential to be developed. One way to increase soybean productivity is by using Rhizobium or arbuscular mycorrhiza fungi. Arbuscular vesicular mycorrhiza is directly related to the surrounding soil through external hyphae which extends in the soil and increases the potential of root system for absorption of nutrients and water and plays a major role in improving soil structure for aeration and water location (Linderman, 1992).

Mycorrhizal plants are able to use nutrients more efficient than plants without mycorrhiza. Mycorrhiza infection allows for alteration of growth activity and root exudate. The mycelium will cause an expansion of the root surface resulting in an increase in absorption of mineral nutrients and water (Hamida, 2010).

Mycorrhiza application can help in the absorption of nutrients and water in plants, especially in legume plants because it can help to improve the plant growth and productivity. Nutrient uptake increases in roots containing mycorrhiza, due to mycorrhiza active uptake and transportation of nutrients. The presence of external hyphae in mycorrhiza functions to absorb nutrients and water in the soil. External hyphae associated with plants will play an important role in expanding the area of root adsorption so as to allow the roots to absorb nutrients and water in a wider range (Mosse, 1981). Rungkat (2009) explained that plants suffered from mycorrhiza usually grow better than plants that do not.

In this study, the application of mycorrhiza was carried out on seeds before planting. Molasses is used as a seed adhesive medium with mycorrhiza. Mycorrhiza apllication is done with and without seed encapsulation using montmorillonite clay minerals. Encapsulation is done one day before planting. Encapsulation can be used to save seeds and germplasm. For the long term, encapsulation is used to protect somatic embryos, adhesion of a microorganism, and protection against pathogens by apllying antibiotics or pesticides. Seed encapsulation has the same meaning as synthetic seed (Devi, *et al.,*2004).

In legumes, for example in soybeans the presence of mycorrhiza is synergistic with other potential microbes such as N-fixing bacteria and phosphate solvent bacteria. Mycorrhiza associated with roots also plays a role in soil conservation. Formation of a good soil structure is important to improve the physical properties of the soil. Improvement of soil structure will also directly affect the development of plant roots. In general, the symbiotic relationship between plants and arbuscular mycorrhiza fungi can be considered to be not specific but has a broad spectrum, meaning that a particular mycorrhizal species can colonize and be effective against more than one particular type of plant. Mycorrhiza dependence is relatively different between plant species or even each variety (cultivar) in one species (Azcon and Ocampo, 1981). This might be due to other macro and micro nutrients needed for seed formation or production which are not available because plants do not only need phosphorus, nitrogen and potassium only to increase grain production and quality (Sutejo, 2002).

The nature of the results observed in this study were the number of pods per plant, number of seeds per plant, percentage of filled seed per plant, seed weight per plant, weight of 100 seeds, and weight of seed per hectare with three kinds of treatments, the addition of mycorrhiza, mycorrhiza + encapsulation, and without mycorrhiza use three soybean varieties namely Anjasmoro, Argomulyo, and Grobogan. Mean comparative analysis showed that the best results for all traits were shown by Anjasmoro with treatment without mycorrhiza.

Data on seed weight per plant (Figure 4) showed significant different on Anjasmoro and Grobogan varieties. In Grobogan variety, significantly differents were seen between mycorrhizal + encapsulation treatment without mycorrhiza treatment and with mycorrhiza. Although showing significantly different results, but the results are significantly different than the other two treatments. In Anjasmoro varieties, the treatment without mycorrhiza is significantly different from the treatment of mycorrhiza + encapsulation and treatment with mycorrhiza. The yield of seed weight per plant with treatment without mycorrhiza also showed the highest yield. Although some previous studies can prove that mycorrhiza can increase crop productivity, but in this study mycorrhiza is not able to increase productivity. This is thought to be caused by competition between the elements needed between plants and inoculated mycorrhiza. Mycorrhiza inoculation can sometimes result in stunted growth of colonized plants. According to Pang and Paul (1980), competition against photosynthates may be the answer to the occurrence of obstacles to the growth of arbuscular mycorrhizal fungi and plant growth so that the addition of mycorrhiza cannot increase yields on inoculated plants. Besides environmental conditions such as pH levels, P and N concentrations and water availability can inhibit the life of mycorrhizae in the soil (Boddington and Dodd, 1999).

CONCLUSION

1. Encapsulation of soybean seeds enriched with mycorrhiza did not show significant different when compared to other treatments.
2. Mycorrhiza did not have a significant effect on the growth and yield of soybeans.

DAFTAR PUSTAKA

Anonim. 2016. Outlook Komoditas Pertanian Tanaman Pangan: Kedelai. Pusat Data dan Sistem Informasi Pertanian, Kementerian Pertanian.

Azcon, R. And J.A. Ocampo. 1981. Factors affecting the vesicular-arbuscular infection and mycorrhizal dependency of thirteen wheat cultivars. New Phytol 87: 677-685.

Boddington, C.L. dan J.C. Dodd. 1999. Evidence that differences in phosphate metabolism in mychorrhizae formed by species of glomus and gigaspora might be related to their life cycle strategies in khotamasi. Tropical Ecology 42: 1-13.

Devi, P., P. Radha, L. Sitamahalakshmi, D. Syamala, dan S. M. Kumar. 2004. Plant regeneration via somatic embryogenesis in mung bean [*Vigna radiata* (L) Wilczek]. Scientia Horticulturae 99: 1 – 8.

Hamida, R. 2010. Efektivitas Mikoriza Vesikular Arbuskular dan Penambahan *5-Aminolevulinic* Acid Terhadap Pertumbuhan Jagung Lokal (*Zea mays* L. Var. Guluk-guluk) pada Intensitas Penyiraman yang Berbeda. Thesis. Program Pascasarjana Program Studi Biologi Universitas Gadjah Mada.

Linderman, R.G. 1992. Mychorriza in Sustainable Agriculture. American Society of Agronomy. USA.

Mosse, B. 1981. Advances in The study of vesicular-arbuscular mycorrhiza. Annu. Rev. Phytopathol 11 : 171 – 96.

Muhammad, H., A. Rochim., S. Sabiham., dan H. Adijuwana. 2000. Serapan maksimum sulfat pada tanah Vertisol, Inceptisol, dan Entisol dari Kabupaten Jeneponto. Jurnal Tanah Tropika 10: 153-159.

Pang, P.C. and Paul E.A. 1980 Effect of VAM on ^{14}C and ^{15}N distribution on nodulated fababeans. Can. J. Soil. Sci. 60: 241-249.

Pato, U. dan Yusmarini. 2002. *Gizi dan Pangan*. Unri Press. Pekanbaru. 143hal.

Permanasari, I., K. Dewi, M. Irfan, dan A. T. Arminudin. 2016. Peningkatan efisiensi pupuk fosfat melalui aplikasi mikoriza pada kedelai. Agroteknologi 6(2) : 23-30.

Rukmana, R. dan Y. Yuniarsih. 1996. *Kedelai. Budidaya & Pasca Panen*. Kanisius. Yogyakarta.

Rungkat, J.A. 2009. Peranan MVA dalam Mengingkatkan Pertumbuhan dan Produksi Tanaman. Jurnal FORMAS 4: 270-276.

Simanungkalit, R. D. M. 1993. Efficiency of vesikular-arbuscular mycorrhizal (VAM) fungi-soybean symbiosis at various levels of P fertilizer. Biotrop. Special Publication No 42.

Sutejo, M.M. 2002 Penerapan Pertanian Organik. Kanisius, Yogyakarta.