Journal of Tropical Mycorrhiza
https://journal.ami-ri.org/index.php/JTM
E-ISSN 2829-467X
Vol. 2 No. 2 October 2023

Application of Arbuscula Mycorrhizal Fungi to Increasing N-total and P-available Soil for Eggplant *(solanum melongena* l.) Growth on Ultisol Soil

Ferdi[*1], Husna[2], Namriah[3], Darwis DEA[4], Zulfikar[5], Resman[6]
[1,2,3,4,5,6]Department of Soil Science, Faculty of Agriculture, Haluoleo University, Kendari, Southeast Sulawesi. 93121, Indonesia.
*Corresponding author: Ferdibutur108@gmail.com

ABSTRACT. Ultisol land is a physically and chemically poor piece of land because it needs special handling that must be done with extreme caution. Mikoriza Arbuskula fungi is one biological fertilizer technique to get around this issue. One of the tiny soil creatures that can coexist with the roots of land plants is the fungus Mikoriza Arbuskula. In order to support plant development and make it simpler for plants to absorb nutrients and maintain soil moisture, Mikoriza Arbuskula Fungi can symbiose with plant roots and form HIFA around young roots. The purpose of this study is: (1) to determine the effect of the application of the Mikoriza Fungi Arbuskula on increasing N-total and P-available on ultisol soil, (2) to determine the effect of the best Mikoriza Arbuskula Fungi application on the growth of eggplant in Ultisol. This research was conducted on experimental land II and the Laboratory of Ami Calay Sultra Faculty of Forestry University of Halu Oleo Kendari. The study was conducted in November - January 2023. This study used a group of randomized groups (shelves). Mushroom Mikoriza Arbuskula consists of 5 levels, namely M0 = without treatment, M1 = 5 g /polybag^{-1}, M2 = 10 g / polybag^{-1}, M3 = 15 g / polybag^{-1}, M4 = 20 g / polybag^{-1}. The results of the study show that the Mikoriza Arbuskula fungi affected the total increase in N and P-available ultisol soil, the results of the initial analysis of 0.03% increased to 0.13% and P available from 9.00 ppm increased to 17.50 ppm. Mikoriza arbuskula fungi with a dose of 20 g / polybag^{-1} provides better eggplant plant growth.

Keywords : *Arbuscular Mycorrhizal Fungi, Soil Chemical Properties, Eggplant Ultisol Soil*

INTRODUCTION

Agriculture is the utilization of biological resources carried out by humans by planting productive plants that can produce and be used for daily life or all activities related to agriculture, plantations, forestry, animal husbandry and fisheries whose results can be used for human life. Ultisols have low N-Total and Available P problems (Sujana *et* al., 2015).

One of the biofertilizer technologies to overcome this problem is by using arbuscular mycorrhizal fungi. Arbuscular mycorrhizal fungi are one of the soil microorganisms that can symbiosis with land plant roots (Smith, 2008). Arbuscular mycorrhizal fungi have the ability to symbiosis with plant roots to form hyphae around young roots so that they are useful for supporting plant growth, making it easier for plants to absorb nutrients and maintaining soil moisture (Cozzolino et al., 2013).

Arbuscular mycorrhizal fungi which are symbiotic with plant roots will produce secretions in the form of acid phosphatase and organic acids which function to chelate Al metal to form insoluble Al organic compounds, thereby reducing the solubility of Al ions, reducing Al-dd concentrations in acid soils. and raise soil pH so that P availability increases (Khairuna *et* al., 2015).

Eggplant is a plant that requires relatively high levels of nutrients, especially nutrients N and P. Nitrogen (N) is used to produce a lot of green material in the form of leaves and

stems. So it is an important element for the growth of eggplant plants. The element nitrogen (N) is mainly needed in the vegetative phase which plays a role in the formation of chlorophyll, amino acids, enzymes and other compounds.

Nitrogen (N) is absorbed by plants almost entirely in the form of nitrate (NO_3^-) or ammonium salts (NH_4^+). Plants that experience a deficiency of Nitrogen (N) show symptoms of stunted and yellowing plant growth. While the element Phosphorus (P) plays a role in generative propagation, for plants it helps the formation of proteins and minerals that are useful for stimulating root growth, helping assimilation and respiration, and accelerating flowering, seed ripening and fruit (Banyumas, 2011).

For this reason, it is necessary to make efforts to increase the productivity of eggplant (solamun melongena L.) with an organic cultivation system by administering certain doses of mycorrhizal biofertilizers which are expected to increase the availability of N-Total and P-Available soil and improve soil structure. This study aims to determine the effect of the application of arbuscular mycorrhizal fungi on total N and available P properties in ultisol soil and the effect of the best application of arbuscular mycorrhizal fungi on the growth of eggplant plants in ultisol soil.

MATERIALS AND METHODS

Location and Time of Research. This research was conducted in the Laboratory Field, Faculty of Agriculture, University of Halu oleo. This research was conducted during three months from November - January 2023. Tools used in research These include: hoe, gembor, machete, bucket, scissors, sack, marker, camera and tools write write. The materials used in this study were polybags (40 cm × 40 cm), eggplant seeds, Ultisol soil, arbuscular mycorrhizal fungi and waring.

Research design. This study used a randomized block design (RAK) namely the administration of arbuscular mycorrhizal fungi (M) consists of 5 levels, namely:

1. (M0) without arbuscular mycorrhizal fungi.
2. (M1) arbuscular mycorrhizal fungi at a dose of 5 g polybag^{-1}.
3. (M2) arbuscular mycorrhizal fungi at a dose of 10 g poibag^{-1}.
4. (M3) arbuscular mycorrhizal fungi at a dose of 15 g polybag^{-1}.
5. (M4) arbuscular mycorrhizal fungi at a dose of 20 g polybag^{-1}.

Each treatment level was repeated 3 times to obtain 15 experimental units.

Research Procedures

1. Preparation of Research Locations
   Preparation of the research location, starting with cleaning the location to be used from weeds and dirt / garbage. Next is manufacturing a place to facilitate the placement of trial polybags in accordance with the floor plan study.
2. Preparation of Planting Media
   The planting medium used in this study is Ultisol soil sterilized for 6 hours. Media that is ready to put into polybags measuring 30 X 30 cm. Each polybag was filled with 5 kg of soil.
3. Eggplant Seed Nursery
   Eggplant seeds that have been selected according to the seed requirements are sown first by spreading the seeds over the nursery, cover the seeds with thin soil, the seeds that have been sown are covered with banana leaves or other coverings after the seeds If it appears to germinate or emerge, open the lid and water the nursery morning and evening day.

Nurseries are approximately 15-25 days old or have 4 leaves ready to be moved to polybags.

4. Preparation of Arbuscular Mycorrhizal Fungi
   Mycorrhiza was obtained from the AMI Calay Sultra Laboratory, Faculty of Forestry Halu Oleo University, which is ready to use. The mycorrhizae to be used are ± 1 kg of Glomus Coronatum and Glomus Claroideumde mixture.
5. Planting
   Seedlings that have been sown for 25 days after sowing and have 3 leaves 4 strands. Choose seeds that thrive and are normally planted upright in the hole in a polybag that has been prepared then the soil around the planting hole is compacted flush with water.
6. Application of Arbuscular Mycorrhizal Fungi
   The application of arbuscular mycorrhizal fungi is given together with eggplant seeds At the time of transplanting, arbuscular mycorrhizal fungi were added to the per planting hole polybag with doses of 5 g, 10 g, 15 g and 20 g.
7. Maintenance
   Maintenance needs to be done so that plant growth is more optimal. As for maintenance activities as follows:
   a. Sprinkling
      Watering is done regularly every morning and evening, especially in the initial phase growth and dry weather conditions it is important because to keep the soil in order neither dry nor too wet. The watering method is watering with a tool water hose.
   b. Soil ExplosionLoosen the soil so that eggplant growth does not occur competition with weeds and more fertile growth.
8. Preliminary Soil Analysis
   Preliminary soil analysis was carried out to determine the increase in N-Total and P Ultisol soil was available prior to the application of arbuscular mycorrhizal fungi.
9. Final Soil Analysis
   Final soil analysis was carried out to determine the increase in N-Total and P Ultisols were available after application of arbuscular mycorrhizal fungi.

Observational Variables

1. Field Observations
   Observation parameters that will be observed in the field are:
   a. Plant height (cm^2)
      Plant height will be measured using a ruler from the ground surface up to the highest part of the plant pass planting and age 14, 28, 45 days after transplanting Planting starts from the beginning of the middle observation and the end of the observation.
   b. Number of leaves (strands)
      The number of leaves is observed by counting the leaves that have been formed perfect pass planting and age 14, 28, 45 days after transplanting.
2. Observations in the Laboratory
   Laboratory tests were carried out to find out P-Available and N-Total on Ultisol soil before and after treatment using the method as follows :
   a. P – Available using the Bray-I method
   b. N – Total using the Kjehldal method

Data analysis

Data from the analysis of N-total and P-available soil are presented in tabular form. Data The plants were processed using variance and if they had a significant effect, they were continued with the BNJ test at the level of 95%.

RESULTS AND DISCUSSION

Results of analysis of soil chemical properties prior to application of Arbuscular Mycorrhizal Fungi

Results of analysis of soil chemical properties prior to application of Arbuscular Mycorrhizal Fungi presented in Table 1.

Table 1. Results of Analysis of Ultisol Soil Chemical Properties before Application of Arbuscular Mycorrhiza.

No	Parameter	Mark	Unit	Criteria
1.	P-available	9.00	Ppm	SR
2.	N- Total	0,03	%	SR

Source: Nano Science Technology Laboratory, 2022. Description: SR= Very Low.

The results of the analysis of the chemical properties of Ultisol soil in Table 1 show that P available 9.00 ppm (Very Low) and N-total 0.03% (Very Low).

Results of Analysis of Ultisol Soil Chemical Properties After Research

Results of analysis of the chemical properties of Ultisol soil after the application of Arbuscular Mycorrhizal Fungi presented in Table 2.

Table 2. Results of Analysis of Chemical Properties of Ultisol Soil after Application of Mycorrhizal Fungi Arbuscle

N0	Treatment	Parameter					
		P-available (ppm)	% Increase vs P- available (initial)	% Increase vs control	N- Total (%)	% Inhancement Vs N-Total (initial)	% Inhancement vs kontrol
1.	M0	7,91 (SR)	-	-	0,02 (SR)	-	-
2.	M1	10,07 (R)	11,87	27,31	0,04 (SR)	31,33	100
3.	M2	12,28 (R)	36,44	55,25	0,05 (SR)	66,67	150
4.	M3	14,37 (R)	59,67	81,67	0,07 (SR)	133,33	250
5.	M4	17,50 (R)	94,44	121,24	0,13 (R)	333,33	550

Source: Nano Science Technology Laboratory, 2022.

Note: R = Low SR = Very Low

The chemical properties of the soil show ionic activity which cannot be seen directly but can be tested using chemicals. Soil chemical properties can also be used as a recommendation in fertilizing for plant nutrients (Wilson et al., 2015).

Based on the results of the final analysis of P-available soil samples after the research in Table 2, it is known that some of the chemical properties of the soil have increased. Application of arbsccular mycorrhizal fungi showed better results than no treatment. The treatment experienced an increase compared to the control, namely M1 27.31%, M2 55.25%, M3 81.67% and M4 121.21%. Whereas compared to the initial analysis of available P 9.00 ppm the application of Arbuscular Mycorrhizal fungi respectively M1 11.87%, M2 36.44%, M3 59.67% and M4 94.44%. According to Suherman et al., (2015) that giving too little Arbuscular Mycorrhizal Fungi or even giving too much Arbuscular Mycorrhizal Fungi can cause competition between Arbuscular Mycorrhizal Fungi so that the results obtained are not optimal.

The effect of giving Arbuscular Mycorrhizal Fungi 20 g per polybag on available-P levels in the study results increased from available-P levels of 7.91 ppm without treatment, which increased more than 1-fold after being given Arbuscular Mycorrhizal Fungi with a value of 17.50 ppm121, 24% whereas when compared with the initial analysis, P-available increased by 94.44%. This is because colonization of Arbuscular Mycorrhizal Fungi will produce organic acids which can release Al-P bonds and bonds with soil clay minerals so that P becomes available to plants. This is reinforced by the results of Nurmasyitah's research (2013) that colonization of the Arbuscular Mycorrhizal Fungi was able to release element P which was fixed by heavy metals to become available to plants with available P levels before treatment, namely 1.01 ppm after being given Arbuscular Mycorrhizal Fungi P. -available increased to 2.12 ppm. In addition, there is a role for Arbuscular Mycorrhizal,Fungi colonization in increasing P-available by forming external hyphae which function to reach nutrients outside the host plant root area and can increase nutrient absorption.

Based on the results of the final analysis of N-total soil samples after the research, it is known that some of the chemical properties of the soil have increased. The application of arbsccular mycorrhizal fungi 20 g per polybag showed better results than no treatment, with an increase of 500% over the control, an increase of more than 5 times. Likewise, compared to the initial analysis, the N-total of 0.03% experienced an increase of 333.33%, an increase of more than 3 times. In the N treatment, the total soil increased where the Arbuscular Mycorrhizal Fungi were able to decompose plant tissues, releasing C and N nutrients, utilizing some of these nutrients together. The increase in soil total N-supply is due to the ability of Arbuscular Mycorrhizal Fungi to accumulate and mobilize N from organic sources (Barrett et al., 2011).

There are three things that cause the loss of total N from the soil, namely nitrogen can be lost due to washing with drainage water, evaporation and absorption by plants (Silahooy et al., 2013). According to Harahap et al., (2018) that mycorrhiza is able to increase the area of absorption of water and nutrients, by using fine hyphae so that it allows it to absorb more water in mycorrhizal plants, greater water absorption by mycorrhizal plants will carry nutrients easily soluble such as N-total so that nutrient uptake increases.

Number of Arbuscular Mycorrhizal Fungi Spores

The results of the analysis of the initial number of Arbuscular Mycorrhizal Fungi Spores and on growth of eggplant plants aged 45 HST on Ultisol soil is presented in Table 3.

Table 3. Results of Analysis of Initial Spore Counts of Arbuscular Mycorrhizal Fungi and on Growth of Eggplant Plants aged 45 HST on Ultisol Soil.

No.	Treatment	Dosage/poly bag	Number of Spores Beginning	Number of Spores 45 HST
1.	M0	0 g	-	35
2.	M1	5 g	14	78
3.	M2	10 g	18	86
4.	M3	15 g	38	77
5.	M4	20 g	44	92

Based on the results of the analysis of the number of Arbuscular Mycorrhizal Fungi Spores on eggplant plants 45 HST on Ultisol soil Table 4.3. that the content of the number of spores has increased from the initial analysis of spores. In the initial analysis of Spores M1 at a dose of 5 g totaled (14), M2 at a dose of 10 g totaled (28), M3 at a dose of 15 g totaled (38) and M4 at a dose of 20 g totaled (44) while after 45 HST all treatments were M1 (78) , M2 (86), M3 (77) and M4 (92) experienced an increase.

Number of Root Colonization

The results of analysis of the number of root colonization on eggplant growth at 45 DAP with the application of Arbuscular Mycorrhizal Fungi are presented in Table 4. The percentage of Arbuscular Mycorrhizal Fungi that colonize roots is the basis for determining colony status in plants. The status of the root colonies was classified into five categories indicating non-colonized status, low, medium, high, and very high (Nusantara et al., 2012).

Table 4. Average results of analysis of the number of root colonization on eggplant growth aged 45 DAP with the application of Arbuscular Mycorrhizal Fungi on Ultisol Soil.

No	**Treatment**	**(%) Colonization**	**Status Colonization**	**FMA Structure (%)**					Amount
				HI	HE	V	A	HC	
1.	M0	13	S	100,00	0,00	0,00	0,00	0,00	100
2.	M1	55	T	100,00	0,00	0,00	0,00	0,00	100
3.	M2	80	ST	94,12	0,00	5,90	0,00	0,00	100
4.	M3	70	T	100,00	0,00	0,00	0,00	0,00	100
5.	M4	45	T	100,00	0,00	0,00	0,00	0,00	100
Rata-Rata		52,6	T	98,82	0,00	1,18	0,00	0,00	100

Description: M0 = Control/without mycorrhiza, M1 = 5g mycorrhiza, M2 = 10g mycorrhiza, M3 = 15g mycorrhiza and M4 = 20g mycorrhiza, S = Moderate, T = High and ST = Very High, HI = Internal Hyphae, HE = External Hyphae, V = Vesicles, HC = Coil Hyphae and A = Arbuscles.

Results of analysis of the number of root colonization on eggplant growth at 45 DAP with the application of Arbuscular Mycorrhizal Fungi on Ultisol Table 4. That there was mycorrhizal infection in eggplant roots in treatments M1, M2, M3 and M4. The number of mycorrhizal infections in the roots in treatment M1 was 55%, M2 was 80%, M3 was 70%, M4 was 45% while the control M0 was colonized by Arbuscular Mycorrhizal Fungi. According to Permanasari et al., (2016), the number of spores is one of the factors that affect mycorrhizal colonies on plant roots. The higher the number of mycorrhizal spores, the higher the number of mycorrhizal colonies on plant roots in the soil. Besides being influenced by the number of spores, mycorrhizal colonization is also influenced by the host plant roots (Yurisman et al., 2015).

This study used sterile soil but in fact mycorrhizal spores were still found in the control treatment without M0 mycorrhiza and this was probably caused by the mixing of the soil when filling the polybags, the use of water for sprinkling or because the plant roots penetrated the polybags. According to Sanggilora et al., (2020), the higher the dose of mycorrhiza given, the higher the chance of infection. The degree of mycorrhizal colonization is also influenced by various factors. According to Wicaksono et al., (2014) the degree of mycorrhizal colonization is influenced by several environmental factors such as soil moisture, available nutrients in the soil to soil pH, besides that it is also determined by the type of fungus and the characteristics of the plant to be colonized. An increase in the degree of mycorrhizal infection may indicate that the mycorrhizae are more active in infecting roots and expanding the root uptake area for water and nutrients, Musafa et al., (2015).

Eggplant Plant Growth Parameters

Recapitulation of the results of the variance of the effect of Arbuscular Mycorrhizal Fungi treatment on the growth of eggplant plants aged 45 DAP is presented in Table 5. analysis of variance showed that the treatment of Arbuscular Mycorrhizal Fungi did not significantly affect plant height and number of leaves of eggplant.

Table 5. Recapitulation of the effects of Arbuscular Mycorrhizal Fungi on eggplant growth on Ultisol soil.

No	Observation Parameters	Variety Print Results	KK
1.	Plant height	tn	10.40
2.	Number of leaves	tn	28.92

Description: tn = No significant effect
KK = Coefficient of Diversity

Based on the recapitulation of the variance of the Arbuscular Mycorrhizal Fungi treatment on eggplant plant growth, the observation variables of plant height and number of leaves had no significant effect.

Eggplant Plant Height

The results of the BNJ test at 95% level of application of arbuscular mycorrhizal fungi to the average height of eggplant (Solanum melongena L.) on Ultisol soil are presented in Table 6. The average yield of eggplant plant height showed that the application of Arbuscular Mycorrhizal Fungi had no significant effect at 45 HST.

Table 6. Effect of application of Arbuscular Mycorrhizal Fungi on Eggplant Plant Height (Solanum melongena L.) At 45 HST.

No.	Treatment of Arbuscular Mycorrhizal Fungi	Average Height (cm)
1.	M0	7,42
2.	M1	7,59
3.	M2	8,16
4.	M3	8,61
5.	M4	8,62

Description: The numbers followed by the same letter are not significantly different at the 95% confidence level, M0 = Control/ without mycorrhiza, M1 = 5g mycorrhiza, M2 = 10g mycorrhiza, M3 = 15g mycorrhizae and M4 = 20g mycorrhizae.

However, based on Table 6. The results of the BNJ test with a confidence level of 95% at 45 DAP, showed that the application of Arbuscular Mycorrhizal Fungi with M4 doses of 20 g tended to produce the best average eggplant height of 8.62 cm compared to other Arbuscular Mycorrhizal Fungi treatments and control.

Number of Leaves

The results of the BNJ test at the 95% level, the average observation of the number of leaves of the eggplant plant is presented in Table 4.7. The average results showed that Arbuscula Mycorrhiza had no significant effect on the number of eggplant leaves at 45 HST.

Table 7. Effect of Arbuscular Mycorrhiza on Number of Leaves of Eggplant (Solanum melongena L.) in Ultisol soil aged 45 HST.

No.	Treatment of Arbuscular Mycorrhizal Fungi	Average Number of Leave (Strands)
1.	M0	3,33
2.	M1	4,00
3.	M2	3,74
4.	M3	3,83
5.	M4	4,00

Description: Numbers followed by the same letters are not significantly different, M0 = Control/without mycorrhiza, M1 = 5 g mycorrhizae, M2 = 10 g mycorrhizae, M3 = 15 g mycorrhizae and M4 = 20 g mycorrhizae.

However, based on Table 7. The results of the BNJ test with a confidence level of 95% at 45 DAP, showed that the application of Arbuscular Mycorrhizal Fungi in the M4 treatment tended to produce the highest number of leaves compared to the control treatment M0.

The results showed that the application of Arbuscular Mycorrhiza to Ultisol soil gave the best results on eggplant plant growth compared to no treatment. This is in line with the increasing value of P-available and N-total in each treatment. The best results were seen in the height growth of eggplant plants, namely the treatment of Arbuscular Mycorrhizal Fungi 20 g per polybag with an average of 8.62 (cm2) at 45 DAP, the average number of leaves was 4 strands. This is because the higher the application of Arbuscula mycorrhiza, the more it will affect the growth and yield of eggplant. This is in accordance with the opinion (Cozzolino, 2013) that the administration of arbuscular mycorrhiza has the ability to symbiosis with plant roots to form hyphae around young roots so that it is useful to support plant growth, make it easier for plants to absorb nutrients and maintain soil moisture.

Arbuscular mycorrhiza as fungal colonization is considered as a key factor in maintaining the stability of the ecosystem of plant species including eggplant. Arbuscular mycorrhiza is applied to lead to plant development through adjustment of phytohormones. Arbuscular mycorrhizal fungi on eggplants can be caused by meeting the needs of macronutrients. Nitrogen serves to stimulate plant growth while phosphorus (P) functions to stimulate flowering, fertilization and seed formation (Muzakkir, 2010).

CONCLUSION

Based on the results of the research and discussion it can be concluded as follows:

1. The application of AMF by administering a dose of 20 g/polybag-1 effectively increased the N-total Ultisol soil with a pre-treatment value of 0.03% increased to 0.13%, an increase of 333.33% compared to the initial analysis. an increase of 550% when compared to without AMF.

2. Application of AMF by administering a dose of 20 g effectively increased P-available with a pre-treatment value of 9.00 ppm and increased to 17.50 ppm, an increase of 94.44% and 121.24% when compared without AMF.
3. Application of AMF experienced an increase in colonization for 45 DAP but not significant to plant growth

REFERENCES

Banyumas., 2011. Fertilizer content in animal manure is available at http: //banyumas.blogspot.com/ 2011/08/kandungan-pupuk-pada-kotoran-dindinghtm.

Barret, G, C.D. Champhell, AH Fitter, & a. Hodge. 2011. The arbuscular mycrrizal flungus (Glomus hoi can capture and transfer nitrogen from organic patches to its associated host plant at low temperature. Appl soil Ecol.

Cozzolino, V., VD Meo and A. Piccolo. 2013. Impact of Arbuscular Mycorrhizal Fungi Applications on Maize Production and Soil Phosphorus Availability. Journal of Geochemical Exploration 129:40–44.

Harahap, LH, AS Hanafiah and H. Guchi. 2018. The effectiveness of mycorrhizal application on the absorption of N and P nutrients from rubber plants on drought stressed land that has been given organic matter. Agroecotechnology. 6(1): 167- 173.

Hardjowigeno, S., 2010. Soil Science, 7th printing. Preesindo Academy, Jakarta. Journal of Agroecotechnology. 4(1):1796– 1803.

Khairuna, Syafrudin and Marlina. 2015. Effect of Arbuscular Mycorrhizal Fungi and Compost on Soybean Plants on Soil Chemical Properties. Floratek Journal 10:1-9.

Masni, ER., Bintang and Purba M., 2015. The effect of the interaction of mineral and organic matter on the chemical properties of Ultisols and the production of mustard plants. Journal of Online Agrotechnology. Vol 3 (4).

Musafa, BLQ Aini, and B. Prasetya, 2015 "The Role of Arbuscular Mycorrhiza and Pseudomonas fluorescens Bacteria in Increasing P Uptake and Growth of Corn Plants in Andisols," J. Soil and Sumberd. Land, vol. 2, no. 2, pp. 191–197.

Muzakkir, 2011, Relationship Between Indigenous Arbuscular Mycorrhizal Fungi and Soil Chemical Properties in the Critical Land of Tanjung Alai, West Sumatra, Solum Journal, vol. 8, no. 2, p. 53-57

Nurmasyitah, Syafruddin and M Sayuthi. 2013. Effect of Soil Type and Dosage of Arbuscular Mycorrhizal Fungi in Soybean Plants on Soil Chemical Properties. Journal of Agrista 17(3):103-110.

Nusantara, AD, Bertham, YH and Mansur, I. 2012. Working with Arbuscular Mycorrhizal Fungi. Faculty of Forestry Bogor Agricultural University and SEAMEO BIOTROP.

Permanasari, I., Dewi, KM, Irfan, M. and Arminudin, AT 2016. Increasing the efficiency of phosphate fertilizers through the application of mycorrhiza to soybeans. Journal of Agrotechnology 6(2):23-30.

Sanggilora, AS Nurhatika, 2020. Arbuscular Mycorrhizal Inoculation on AMB-P07 Growing Media on Fruit Production and Antioxidant Activity of Purple Eggplant Solanum melongena var. Mustang F1, J. Science and Art.

Silahooy CH, Patti PS, Kaya E. 2013. Analysis of Soil Nitrogen Status in Relation to N Uptake by Lowland Rice Plants in Waimital Village, Kairatu District, West Seram District. Journal of Agrology. 2(1) 51-58.

Smith, SE & Read, DJ 2008. Mycorrhizal symbiosis. Third edition: Academic Press. Elsevier Ltd. New York, London, Burlington, San Diego.

Suherman, C., WH Rizky and IR Dewi. 2015. The effect of the application of arbuscular mycorrhizal fungi (FMA) and root growth regulators (ZPT) in increasing the number of seeds ready for distribution of tea plants (Camellia sinensis (L.) O. Kuntze). Tea and Quinine Research Journal, (18)2: 131 – 140.

Sujana., I. P and I Nyoman., LSP, 2015. Ultisol Soil Management by Providing Organic Biochar Material Towards Sustainable Agriculture. Agrimeta. Vol. 05 (09).

Wicaksono, M. l., Rahayu, and S. Samanhudi, 2014. Effect of Mycorrhiza and Organic Fertilizers on Garlic Growth, Caraka Tani J. Sustain. Agric., Vol. 29.

Wilson, Supriadi, and G. Hardy. 2015. Evaluation of Soil Chemical Properties in Coffee Lands in Mandailing Natal District. Journal of Agroecotechnology Online. 3(2) : 642-648.

Yurisman, B., Burhanuddin and Wahdina. 2015. Association of arbuscular mycorrhizal fungi (FMA) on bintaro plants (Cerbera manghas Linn.) in Alluvial soils. Journal of Sustainable Forestry 3(4):551-560.