Effect of Giving Arbuscular Mycorrhizal Fungi (AMF) and Bioactivator Dosage of *Trichoderma* spp. on the Growth and Products of soybeans (*Glycine* max L. Merr.)

Siwi Yudhiarti [1], **Made Sudantha** [1], **Taufik Fauzi** [1]

[1] *Universitas Mataram*
62 Jl. Majapahit, Mataram, NTB, Indonesia

DOI: 10.22178/pos.62-13

LCC Subject Category: SB1-1110

Received 19.08.2020
Accepted 25.09.2020
Published online 30.09.2020

Corresponding Author:
Siwi Yudhiarti
imade_sudantha@yahoo.co.id

Abstract. Several factors become an obstacle to increasing soy production and achieving quality standards for soybean yields, including limited water, especially in rain-fed areas, that determine the success of soybean cultivation. The use of Trichoderma spp. Bioactivators and AMF can be a solution for adding organic material to soy cultivation. This study aims to investigate the effect of AMF and the bioactivator Trichoderma spp. on growth, yield in soybeans (Glycine max L. Merr,). The design used is a two-factor split-plot design. Because the main plot was AMF, which consisted of without and with AMF (15 g/plant). The subplot is the dosage of bioactivators (tablet and liquid form with legundi leaves fermented by Trichoderma spp.), Consisting of seven levels without bioactivators, 2.5 g tablets with bioactivators, 5.0 g tablets with bioactivators, and 7.5 bioactivators. g tablets, containing 2.5 ml liquid bioactivator, 5.0 ml liquid bioactivator, and 7.5 ml liquid bioactivator. The treatment was a combination of FMA factor and bioactivator dose, each of which was repeated three times so that there were 42 experimental units. The results showed that the administration of AMF at a dose of 15 g/plant showed better growth of the soybean plant and yielded a yield of 29.27% or 1.13 tons/ha. While the administration of Trichoderma spp bioactivator at a dose of 5.0 ml can increase the growth of soy plants and give higher yields of dry soybean seeds, namely 31.54% or 1.28 tons/ha.

Keywords: Arbuscular Mycorrhizal Fungi; bioactivator; fungus Trichoderma spp.; soy.

INTRODUCTION

In West Nusa Tenggara, the development of dryland agriculture is a superior and a mainstay of the future as most of the NTB area, namely 84 % (1.8 million hectares), is dry land that has the potential has to be developed into productive agricultural land for various raw materials. food crops, especially soybeans [17].

Soybean plants have been shown to adapt well to the dry, although the yields obtained are still lower than those in wetlands [3, 2]. Several factors become an obstacle to increasing soy production and achieving quality standards for soybean yields, including limited water, especially in rain-fed areas, that determine the success of soybean cultivation. The yields of soybeans have decreased a lot if, in the critical growth phase, the need for water is not sufficiently available, if you experience drought, the productivity can decrease by 40-65% [9].

Based on the above, the use of problem-solving innovations aimed at improving crop production by improving plant health by improving the physical and biological environment of the soil. The combination of different components of biological technology that provides a synergistic effect on plants and soil systems, such as the use of bioactivators and the use of Arbuscular Mycorrhizal Fungi (AMF) and superior soybean varieties resistant to soil pathogens, is an organic agricultural component that can be applied to soybean crops [25].

Plants will produce good results when all the necessary nutrients are available in sufficient quantities for growth and development. These nutrients can be obtained both organically and inorganically and one of them is fertilization. Organic fertilizer is recommended because it increases the porosity of the soil, which will improve the balance of air and soil moisture. The use of AMF and the bioactivator Trichoderma spp. soil can be used as an alternative to organic fertilization on soil with the nutrient attack.

Using AMF can be done to increase the soil's ability to absorb other nutrients. AMF is one of the components of soil biology that can grow and develop in an environment less favorable to the growth of other soil microbes. The use of mycorrhizal fertilizers is an alternative to increase land productivity. Mycorrhizae can be symbiotically associated with plant roots, which can lead to the formation of wide and greater root uptake, as mycorrhizal fungi have hyphae that can penetrate very small pores in the soil, improving the plant's ability to absorb nutrients, especially nutrients that are relatively immobile such as P, Cu, and Zn.

The fermentation process in the production of liquid organic fertilizers is a process of decomposition or remodeling of organic matter performed under certain conditions by fermentative microorganisms known as bioactivators. Bioactivators are purified microbial isolates and have the special ability to digest organic matter containing cellulose fibers. Through a selection process, the ability to digest cellulosic materials is optimal, then formulated and its application can be used in various fields for the exploration of materials derived from woody organic materials known as biophenaries. One of its uses is to speed up the composting process [31].

MATERIALS AND METHODS

The method used in this study is an experimental method, designed as a two-factor split-plot design. Because the main plot is AMF which consists of two levels, namely without AMF and with AMF (15 g/plant). The plot child is a dosage of bioactivators (tablet and a liquid form containing legundian plants fermented by the fungus Trichoderma spp.) which consists of seven levels, namely without bio-activator, with bio-activator 2.5 g tablet, with bio-activator 5.0 g tablet, with bio-activator 7.5 g tablets, with 2.5 ml liquid bio-activator, 5.0 ml liquid bio-activator, and 7.5 ml liquid bio-activator. The treatment was a combination of AMF factor and bioactivator dose (tablet and liquid form), each repeated three times so that there were 42 experimental units.

Tillage was carried out with a hoe to level the soil and then a 2 m × 4 m plot was made for each treatment plot. After processing the soil, the basic fertilization takes place with Phonska fertilizer 100 kg/ha (50 % of the advice). Basic fertilization is done by submerging it next to the planting hole.

The use of AMF and bioactivator was performed when the seed was poured by dropping the soybean seeds to the sides of the planting hole (about 5 cm from the planting hole). The soybean seeds are inserted 2 cm deep into the hole and the hole is closed again with soil. Planting was carried out at a distance of 20 x 40 cm.

Plant maintenance includes fertilizing, watering, and weeding. Additional fertilization is done when the plants are 5 weeks old after planting. Fertilization follow-up with urea fertilizer 165 kg/ha and KCl 50 kg/ha. Fertilization is done by placing the fertilizer against the base of the plant stem at a distance of ± 2 cm. Irrigation was performed in the morning or evening and was carried out by diluting the experimental land through a channel on the experimental plot until the soil was wet. Weeding is done by removing weeds that grow around the plants.

The variables observed were plant growth (plant height and number of leaves) and the yield of dry seeds per plant and hectare. Observation data were analyzed using Analysis of Variance (ANOVA) with a real level of 5% with Minitab for Windows Rel 13. If there is any variation, a new test is performed using the Honestly Real Difference (BNJ) test at the 5% real level.

RESULTS AND DISCUSSION

Plant Height. The results of observation and analysis of the diversity of the effect of giving AMF and Trichoderma spp. bioactivator each had a significant effect on plant height. The results of further tests to impart AMF and Trichoderma spp. bioactivators to the mean plant height using BNJ at the 5% level are shown in Table 1 and Table 2.

Table 1 shows that giving AMF to soybeans was able to significantly increase plant height in each (3.44%, 12.20%, 14.26%) as compared to the control. This may be because the roots grow better due to the response of AMF application, which can increase the uptake of water and nutrients used in the metabolic process in the plant body so that it can stimulate plant height growth (Utomo, 2009).

The author Simanjuntak (2005) stated that the application of AMF had a significant effect on plant height at age 3 MST, with AMF thought to be associated with the roots of legume plants to help form nodules on the roots as a fixative mediator of nitrogen from the sky. Nitrogen fixation runs smoothly if there is enough P in the roots of the nuts. Nitrogen taken up by these plants will be used by plants to stimulate growth above the ground, especially for the height of the plant and also to give green leaves.

Table 1 – Effect of AMF on plant height parameters

Treatment	Plant Height (cm)		
	14 hst	21 hst	28 hst
Without AMF	28,19 a*)	37,98 a*)	45,51 a*)
With AMF (15 g/plant)	27,25 b	33,85 b	39,83 b
BNJ 5%	0,93	2,67	4,10

Note: *) The numbers in each column followed by the same letter in each treatment are not significantly different in the BNJ test at a 5 % level.

hst = days after planting.

Table 2 – Provision of Trichoderma spp. at plant height

Bioactivator Dose Treatment	Plant Height (cm)		
	14 hst	21 hst	28 hst
Without Trichoderma spp.	25,19 a*)	31,20 a*)	37,72 a*)
Bioactivator tablets 2,5 g/plant	28,37 b	36,50 b	42,42 b
Bioactivator tablets 5,0 g/ plant	28,42 b	36,55 b	44,04 b
Bioactivator tablets 7,5 g/ plant	27,54 b	36,31 b	43,95 b
Liquid bioactivator 2,5 ml/ plant	27,84 b	37,05 b	42,72 b
Liquid bioactivator 5,0 ml/ plant	28,50 c	36,63 b	44,24 c
Liquid bioactivator 7,5 ml/ plant	28,18 b	37,15 c	43,61 b
BNJ 5%	0,93	2,67	4,10

Note: *) The numbers in each column followed by the same letter in each treatment are not significantly different in the BNJ test at a 5% level.

hst = days after planting.

Table 2 shows that the administration of Trichoderma spp bioactivator at different dose levels can have a significant effect on plant height. It can be seen that in general the dosage of Trichoderma spp bioactivator in a dose of 5 ml in liquid form can significantly increase the plant height by (13.14 %, 17.40 %, 19.93 %) compared to the control treatment. The effect of Trichoderma spp bioactivator on plant height may be due to its growth-promoting properties. The saprophytic fungus Trichoderma spp can release chemicals or hormones that are distributed throughout plant tissue and that can stimulate plant growth [25].

According to [26], it was reported in her study that the application of Trichoderma spp bioactivator could increase the growth rate of plant height, number of branches, number of productive branches, dry stubble weight, number of pods formed and filled pods compared to without bioactivator applications.

Number of Leaves. The results of the diversity analysis showed that there was no interaction between the administration of AMF and the administration of Trichoderma spp bioactivator at the age of 14 days after planting (hst) to the age of 28 hst. The results of further tests to give AMF and Trichoderma spp bioactivator on the mean leaf number of plants using BNJ at the 5% level are shown in Table 3 and Table 4.

Table 3 – Effect of AMF on the number of plant leaf parameters

Treatment	Number of Leaves (Sheet)		
	14 hst	21 hst	28 hst
Without AMF	16,81 a*)	19,31 a*)	22,60 a*)
With AMF (15 g/plant)	22,81 b	29,58 b	33,65 b
BNJ 5%	1,71	7,06	6,69

Note: *) The numbers in each column followed by the same letter in each treatment are not significantly different in the BNJ test at a 5 % level.

hst = days after planting.

Table 3 shows that the application of AMF to soybean plants showed a significant increase in the number of leaves (35.69 %, 53.28 %, 57.74 %, respectively) compared to the treatment without AMF. Giving mycorrhizae to plants can increase the uptake of nutrients, especially P, which is important in the photosynthesis process. The author [25] states that active photosynthetic plants will have a positive effect on increasing the number of leaves, the weight of the plant, the root weight, and the canopy so that mycorrhizal plants will have a higher number of leaves and plant weight than plants that do not inoculate with mycorrhizae. Authors [29] also stated that the application of 8 gr/plant the AMF gave the best results on the growth of soybean plants, in this case including plant height and the number of leaves.

Table 4 – Provision of Trichoderma spp. on the leaf number parameter

Bioactivator Dose Treatment	Number of Leaves (Sheet)		
	14 hst	21 hst	28 hst
Without Trichoderma spp.	11,33 a*)	14,20 a*)	16,26 a*)
Bioactivator tablets 2,5 g/plant	14,86 a	22,23 b	24,13 a
Bioactivator tablets 5,0 g/plant	17,36 a	22,33 c	24,60 a
Bioactivator tablets 7,5 g/plant	15,40 a	19,03 b	21,70 a
Liquid bioactivator 2,5 ml/plant	15,63 a	21,46 c	24,11 a
Liquid bioactivator 5,0 ml/plant	12,98 a	15,95 b	19,13 a
Liquid bioactivator 7,5 ml/plant	16,08 a	20,93 c	24,96 a
BNJ 5%	1,71	7,06	6,69

Note: *) The numbers in each column followed by the same letter in each treatment are not significantly different in the BNJ test at a 5% level.

hst = days after planting.

Table 4 shows that at the age of 14, 21, 28 days after planting, the Trichoderma spp bioactivator treatment at a dose of 7.5 ml in liquid form had a significant effect on the number of leaves, respectively (41.92%, 47, 39%, 53.50%) compared to the control treatment. The increase in leaf number based on Table 5.4 shows that the bioactivator from the fermentation of Trichoderma spp can increase the number of shallot leaves. The author [25] stated that Trichoderma spp can increase plant growth and increase the absorption of active minerals and other nutrients from the soil. Othe authors also stated that applying Trihcoderma fungus to the soil can speed up the process of decomposition of organic matter so that the necessary nutrients will be available to support plant growth. The treatment of Trichoderma spp as a biological agent can increase the growth of caisin plants, according to another statement by [17], that like Trichoderma spp can break down organic matter in soil media so that it is converted into a much simpler structure, dissolves easily and can be used. plants as a food source for plant growth.

Planted Seed Weight. The results of the diversity analysis showed that there was no interaction between AMF administration and Trichoderma spp bioactivator at the age of 7 days after planting (hst) until the age of 28 days. The results of further tests in which Trichoderma spp bioactivator was given on the mean leaf number of plants using BNJ at the 5% level are shown in Table 5 and Table 6.

Table 5 – The effect of AMF application on plant seed weight parameters

AMF treatment	Dry seed weight per plant (gr)	Dry seed weight per hectare (ton)
Without AMF	7,08 a*)	0,88 ton/ha
With AMF (15 g/ plant)	9,08 b	1,13 ton/ha
BNJ 5%	1,87	

Note: *) The numbers in each column followed by the same letter in each treatment are not significantly different in the BNJ test at a 5 % level.

hst = days after planting.

Table 5 shows that the application of AMF to soybean plants showed a significant increase in the weight of the planted seeds by (29.27 %) or 1.13 tons/ha compared to treatment without AMF, which yielded only 0.88 tons/ha. In addition to affecting plant growth, the application of AMF at a dose of 15 gr/plant according to [29] also affects the weight of the seeds per plant. This increase is because AMF promotes nutrient absorption and improves the state of nutrients, especially phosphorus [35].

Giving mycorrhizae to plants allows plants to absorb nutrients, especially for phosphorus. The increase of phosphorus in plant tissues influences photosynthetic activity because a higher photosynthesis rate in plants with mycorrhizal is associated with the increase in P [7].

Treatment of Trichoderma spp bioactivator. The weight of soybean seeds, as shown in Table 6 at a dose of 5.0 ml, shows that the weight value of soybean seeds is 1.28 tons/ha. While the AMF treatment at a dose of 15 g/plant in Table 5 gives a yield of 1.13 tons/ha. The Trichoderma spp fungus applied to the soil in liquid form will associate with plant roots and cover the roots which then invade the plant roots. According to [33], Trichoderma spp plays a very important role in maintaining soil fertility and has the potential as an "active compost" that can be used to increase and stimulate the root growth of plants and achieve better results. to give. Authors [4] state that applying an AMF of 450 kg/ha can increase the weight of dry soybean seeds on dry land. Likewise, according to [4], giving an AMF of 450 kg/ha can increase the weight of dry corn seeds on dry land.

Table 6 – Effect of Trichoderma spp. to the dry seed weight of the plant and per hectare

Bioactivator Dose Treatment	Dry Seed Weight per Plant (gr)	Dry Seed Yield per Ha (ton)
Without Trichoderma spp.	7,83 a*)	0,97 ton/ha
Bioactivator tablets 2,5 g/plant	9,36 ab	1,17 ton/ha
Bioactivator tablets 5,0 g/plant	9,26 ab	1,15 ton/ha
Bioactivator tablets 7,5 g/plant	8,75 ab	1,09 ton/ha
Liquid bioactivator 2,5 ml/plant	10,06 ab	1,25 ton/ha
Liquid bioactivator 5,0 ml/plant	10,30 b	1,28 ton/ha
Liquid bioactivator 7,5 ml/plant	10,17 b	1,27 ton/ha
BNJ 5%	1,87	

Note: *) The numbers in each column followed by the same letter in each treatment are not significantly different in the BNJ test at a 5 % level.

hst = days after planting.

Table 6 shows that the effect of using the bioactivator dose of Trichoderma spp 5.0 ml and 7.5 ml in liquid form has a significant effect on the weight of soybean seeds (31.54 % and 29.88 %) with a production of 1.28 tons. / ha and 1.27 tons/ha compared to the untreated Trichoderma spp which achieved only 0.97 tons/ha. The percentage results show that the use of Trichoderma spp bioactivator can increase the weight of the planted seeds higher than without Trichoderma spp bioactivator. This is because the ability to absorb nutrients is more optimal when using Trichoderma spp so that the weight of the seeds planted in soybean plants can increase.

The growth of soybean plants fed Trichoderma spp showed that the mushroom species T. harzianum, T. Koningii, T. viridae could increase plant growth. This is due to the biological agents it contains. Trichoderma supplied with the encapsulation material can increase plant growth.

Biocativators are inoculants that promote plant growth and development [17]. The use of bioactivators (with saprophytic fungus T. Harzianum isolate SAPRO-07 and endophytic T. Koningii isolate ENDO-02) on soy plants in the dry land of Akar-Akar Village, North Lombok Regency can stimulate growth and development [24]. Bioactivator with Trichoderma spp. These can be formulated in liquid, tablet, and granulate form [17]. Authors [14] said that the liquid Trichoderma bioactivator applied to shallot plants can increase the weight of shallot tubers per hectare. Authors [17] revealed that the Trichoderma spp. packaged as liquid biocompost can increase the weight of dry soybean seeds per hectare on dry land.

CONCLUSION

Based on the results and discussion described, it is concluded that: 1) Providing AMF at a dose of 15 g/plant can increase the growth of soybean plants, namely plant height and number of leaves, as well as the weight of the kerting seeds and can increase dry seed weight per hectare; 2) Supply of Trichoderma spp bioactivator in liquid form at a dose of 5.0 ml, can increase soybean plant growth, namely plant height and number of leaves, as well as increase kerting seed weight and dry seed weight per hectare; 3) The application of Trichoderma spp bioactivator at a dose of 5.0 ml gave a higher yield of dry soybean seeds, namely 31.54% or 1.28 tons/ha compared to the application of AMF at a dose of 15 g/ha. plant, namely 29.27 % or 1.13 tons/ha; 4) There is no interaction between AMF administration and the bioactivator Trichoderma spp. on the growth of plant height, number of leaves, dry seed weight per hectare, and dry seed weight.

REFERENCES

1. Adelman, M. J., & Morton, J. B. (1986). Infectivity of vesicular-arbuscular mycorrhizal fungi: Influence of host-soil diluent combinations on MPN estimates and percentage colonization. *Soil Biology and Biochemistry, 18*(1), 77–83. doi: 10.1016/0038-0717(86)90106-9
2. Adisarwanto, T. (2006). *Kedelai*. Jakarta: Penebar Swadaya.
3. Adisarwanto, T. (2008). *Budidaya Kedelai Tropika*. Jakarta: Penebar Swadaya.
4. Astiko, W., & dan Sudantha, I. M. (2020). The Response of Two Maize Genotypes Inoculated with Mycorrhizae on Dry Land North Lombok, Indonesia. *International Journal of Innovative Science and Research Technology, 5*(3), 92–97.
5. Bertham, Rr. Y. H. (2002). Respon tanaman kedelai (Glycine max L. Merril) terhadap pemupukan fosfor dan kompos jerami pada tanah ultisol. *Jurnal Ilmu-Ilmu Pertanian Indonesia, 4*(2), 78–83.
6. Bosland, P. W. (1988). Fusarium Oxysporum, a Pathogen of Many Plant Species. *Advances in Plant Pathology*, 281–289. doi: 10.1016/b978-0-12-033706-4.50023-2
7. Charisma, A. M., Rahayu, S. Y., & Isnawati. (2012). Pengaruh Kombinasi Kompos Trichoderma dan Mikoriza Vesikular Arbuskular (MVA) terhadap Pertumbuhan Tanaman Kedelai (*Glycine max* (L.) Merill) pada Media Tanam Tanah Kapur. *Lentera Bio, 1*(3), 111–116.
8. Departemen Pertanian. (2005). *Prospek dan Arah Pengembangan. Agribisnis Kedelai*. Retrieved from http://www.litbang.pertanian.go.id/special/komoditas/files/00-KEDELAI.pdf
9. Elalayla. (2015, October 16). *Pemanfaatan Potensi Lahan Kering sebagai Penyangga Ketahanan Pangan Di Provinsi Nusa Tenggara Barat*. Retrieved from https://irgendwoichwill.wordpress.com/2015/10/16/pemanfaatan-potensi-lahan-kering-sebagai-penyangga-ketahanan-pangan-di-provinsi-nusa-tenggara-barat
10. Fachruddin, L. (2000). *Budidaya Kacang-Kacangan*. Yogyakarta: Kanisius.
11. Fravel, D., Olivain, C., & Alabouvette, C. (2003). Fusarium oxysporum and its biocontrol. *New Phytologist, 157*(3), 493–502. doi: 10.1046/j.1469-8137.2003.00700.x
12. Hayman, D. S. (1983). The physiology of vesicular–arbuscular endomycorrhizal symbiosis. *Canadian Journal of Botany, 61*(3), 944–963. doi: 10.1139/b83-105
13. Mulyani, A. (2008). *Potensi dan Ketersediaan Lahan untuk Pengembangan Kedelai di Indonesia*. Retrieved from http://203.190.37.42/publikasi/wr301082.pdf
14. Ningsih, D. H., dan Suwardji, M. S. (2019). Application of Liquid Bioactivator Contains Trichoderma spp. and Elements of Boron (B) as Growth of Growth and Improvement of Red Onion (Allium Cepa L.) Results. *International Journal of Multicultural and Multireligious Understanding, 6*(6), 509–525.
15. Osborne, L. E., & Stein, J. M. (2007). Epidemiology of Fusarium head blight on small-grain cereals. *International Journal of Food Microbiology, 119*(1-2), 103–108. doi: 10.1016/j.ijfoodmicro.2007.07.032
16. Özer, N., & Köycü, N. D. (n.d.). Seed-borne Fungal Diseases of Onion, and their control. *Disease Management of Fruits and Vegetables*, 281–306. doi: 10.1007/0-306-48575-3_8
17. Prayoba, U. E., Sudantha, I. M., & Suwardji, S. (2019). Giving of Biochar and Biocompost to Growth, Results and N Uptake Soybean Plants (Glycyne Max (L) Merr.). *International Journal of Environment, Agriculture and Biotechnology, 4*(2), 250–253. doi: 10.22161/ijeab/4.2.2
18. Rossi, V., Languasco, L., Pattori, E., & Giosuè, S. (2002). Dynamics of airborne Fusarium macroconidia in wheat fields naturally affected by head blight. *Journal of Plant Pathology, 84*(1), 53–64.
19. Semangun, H. (1991). *Penyakit-Penyakit Tanaman Pangan Penting di Indonesia*. Yogyakarta: Gajah Mada University Press.

20. Semangun, H. (1994). *Penyakit-Penyakit Tanaman Hortikultura di Indonesia*. Yogyakarta: Gadjahmada University Press.

21. Setiadi, Y. (2000). *Pemanfaatan mikroorganisme dalam kehutanan*. Babakan: Pusat Antar Universitas Bioteknologi.

22. Shahnazi, S., Meon, S., Vadamalai, G., Ahmad, K., & Nejat, N. (2012). Morphological and molecular characterization of Fusarium spp. associated with yellowing disease of black pepper (Piper nigrum L.) in Malaysia. *Journal of General Plant Pathology, 78*(3), 160–169. doi: 10.1007/s10327-012-0379-5

23. Simanjuntak, D. (2005). Peranan Trichoderma, Mikoriza dan Posfat Terhadap Tanaman Kedelai Pada Tanah Sangat Masam (Humitropets). *Jurnal Penelitian Bidang Ilmu Pertanian, 3*(1), 36–42.

24. Sudantha, I. M. (2007). *Karakterisasi dan Potensi Jamur Endofit dan Saprofit Antagonistik sebagai Agens Pengendali Hayati Jamur Fusarium oxysporum f. sp. Vanilla pada Tanaman Vanili di Pulau Lombok NTB* (Doctoral dissertation). Retrieved from https://docplayer.info/135135617-Ringkasan-disertasi-oleh.html

25. Sudantha, I. M. (2009). Uji aplikasi beberapa jenis biokompos (hasil fermentasi jamur T. Koningii isolat ENDO-02 dan T. harzianum isolat SAPRO-7) pada dua varietas kedelai terhadap penyakit layu Fusarium dan hasil kedelai. *Agroteksos, 21*(1), 39–46.

26. Sudantha, I. M. (2019). *Laporan Kegiatan Penelitian Hibah Kompetensi Aplikasi Jamur Trichoderma Spp.* (Isolat Endo-02 Dan 04 Serta Sapro-07 Dan 09) Sebagai Biofungisida, Dekomposer Dan Bioaktivator Pertumbuhan Dan Pembungaan Tanaman Vanili Dan Pengembangannya Pada Tanaman Hortikultura Dan Pangan.

27. Sudantha, I. M., & dan Astiko, W. (2020). Agronomic Response of Soybean Plant in Various Dosage Bio Compos Fermented Fungus of Trichoderma sp. and Arbuscular Mycorrhizae Fungi. *International Journal of Innovative Science and Research Technology, 5*(5), 689–696.

28. Sudhiarti, S. (2017). *Isolasi dan Karakteristik Mikoriza Vesikuler-Arbuskular di Lahan Kering Masam, Lampung Tengah*. Retrieved https://dokumen.tech/document/glycyne-max-l-merr-di-lahan-kering-yudhiarti-dan-i-made-sudantha-topi.html

29. Suherman, R., dan Akib, M. A. (2012). Aplikasi Mikoriza Vesikular Arbuskular Terhadap Pertumbuhan dan Produksi Tanaman Kedelai (*Glycine max* L., Merrill). *Jurnal Galung Tropika, 9*, 1–6.

30. Sulistiawati, F. (2013). *Uji Aplikasi Bioaktivator Jamur Sapro_t dan Endo_t Trichoderma,spp. Terhadap Penyakit Layu Fusarium Pada Beberapa Varietas Tanaman Kedelai (Glycine max (L) Merr.)* (Master's thesis). Mataram.

31. Suwahyono, U. (2014). *Cara Cepat Buat Kompos dari Limbah*. Jakarta: Penebar Swadaya.

32. Talanca, A. H., Soenartiningsih, S. Rahamma, & dan Wakman, W. (2001). Penggunaan Jamur mikoriza Vesicular-Arbuscular (MVA) untuk pengendalian penyakit Hawar Upih daun Jagung (Rhizoctonia solani). *Risalah Penelitian Jagung dan Serealia Badan Litbang Pertanian, 5*, 47–52.

33. Utomo, B. (2010). Pemanfaatan beberapa bioaktivator terhadap peningkatan laju dekomposisi tanah gambut dan pertumbuhan Gmelina arborea Roxb The Use of Bioactivators to Increase the Decomposition Rate of Peat Soil and the Growth of Gmelina arborea Roxb. *Jurnal Penelitian Hutan Tanaman, 7*(1), 33–38. doi: 10.20886/jpht.2010.7.1.33-38

34. Widiarta, S. (2010). *Kebijakan Pengembangan Kedelai Nasional*. Retrieved from http://digilib.batan.go.id/ppin/katalog/file/9789793558257-2010-037.pdf

35. Zuhry, E. dan Fifi Puspita. (2008). Pemberian Cendawan Mikoriza Arbuskular (CMA) pada Tanah Podzolik Merah Kuning (PMK) terhadap Pertumbuhan Dan Produksi Kedelai (Glycine max (L) Merrill). *Jurnal Sagu, 7*(2), 25–29.