The Addition of *Trichoderma* sp. in Various Types of Organic Liquid Fertilizer to Increase NPK Nutrient Uptake and Soybean Production in Ultisol

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ABSTRACT

Indonesia imports up to 70% of its domestic soybean needs from abroad. Therefore, it is necessary to increase soybean yields in Indonesia, among others, by providing Liquid Organic Fertilizer (LOF). The purpose of this study was to determine the effects of LOF enriched with *Trichoderma* sp. on the yield of Mutiara-1 soybean in Ultisol. The experiment was conducted on dry land with a pH of 4.66 (acidic) in Kuranji Village, Kuranji District, Padang. The experiment was arranged in a factorial completely randomized design consisting of two factors, including the dose of Trichoderma sp. and the type of LOF. The doses of Trichoderma sp. inoculants were 0, 1, and 2 kg for every 20 kg of fermented LOF main ingredients. The main ingredients of LOF used in this experiment were *Chromolaena odorata*, *Tithonia diversifolia*, and *Trichoderma* sp. Meanwhile, the type of LOF tested was according to the composition of the main ingredients, consisting of no LOF, Crocober, and Tithocroco. The data obtained were analyzed using ANOVA and continued with the LSD test at a 5% significance level. The results showed that the addition of 2 kg of Trichoderma sp. inoculants to Tithonia + *C. odorata* (Tithocroco) resulted in the highest dry seed production, reaching 3.17 tons ha-1 or an increase of 38.42% compared to those without LOF.

Keywords: *Chromolaena odorata*, Liquid Organic Fertilizer, Soybean, *Tithonia diversifolia*, *Trichoderma* sp.

ABSTRAK

Indonesia mengimpor hingga 70% kebutuhan kedelai domestiknya dari luar negeri. Oleh sebab itu perlu upaya meningkatkan hasil kedelai di Indonesia antara lain dengan pemberian Pupuk Organik Cair (POC). Tujuan penelitian adalah untuk mengetahui peranan dari POC yang diperkaya dengan Trichoderma sp terhadap hasil kedelai Mutiara-1 pada Ultisol.Percobaan telah dilakukan di lahan kering dengan pH 4,66 (masam) di Kelurahan Kuranji, Kecamatan Kuranji Kota Padang. Percobaan menggunakan berbagai jenis bahan utama dijadikan POC antara lain; Chromolaena odorata, Tithonia diversifolia dan Trichoderma sp. Percobaan dirancang dengan rancangan acak lengkap faktorial dengan 2 faktor perlakuan, yaknidosis Trichoderma sp. dan jenis POC. Dosis inokulan Trichoderma sp., terdiri dari 0, 1 dan 2 kg untuk setiap 20 kg bahan utama POC yang difermentasikan. Jenis POC yang diuji didasarkan pada komposisi bahan utama terdiri dari tanpa POC, Crocober dan Tithocroco. Data yang diperoleh dianalisis menggunakan ANOVA pada taraf nyata 5% dan dilanjutkan dengan uji LSD taraf nyata 5%. Dari hasil percobaan maka dapat disimpulkan bahwa pemberian 2 kg inokulan Trichoderma sp pada POC Tithonia + C.odorata (Tithocroco) menghasilkan produksi biji kering tertinggi mencapai 3,17 ton ha^{-1} atau meningkat 38,42% dibandingkan dengan yang tidak diberi POC.

Kata Kunci: Chromolaena odorata, Pupuk Organik Cair, Kedelai, Tithonia diversifolia, Trichoderma sp.

INTRODUCTION

Trichoderma sp. is a saprophytic fungus important in the plant nutrient cycle. This fungus is involved in the transaction of nutrients in nature. *Trichoderma* sp. is commonly used in making organic compost, especially from rice straw. Fermentation of rice straw using *Trichoderma* sp. has a positive impact on increasing the nutrient content of compost and fertilizing the soil. The use of *Trichoderma* sp. has also been developed as a biological agent in increasing plant resistance to disease caused by soil-borne fungi and others (de Oliveira et al., 2014; Chamzurni et al., 2011). *Trichoderma* sp. is believed to be able to accelerate the decomposition of organic matter in nature so that it can shorten the fermentation time, which is quite long. *Trichoderma* is green in color with

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a slightly tart and sweet aroma. Usually, people breed it using rice or rice and bran media. The culture media must contain carbohydrates so that the fungus can live to meet the food from these carbohydrates.

The use of LOF using *Trichoderma* sp. has been reported by Putri& Jamilah (2018).Rizal & Susanti (2018) have also reported increased food crop yields using these fungi as decomposers. The manufacture of liquid organic fertilizer (LOF), which is used by spraying it over the entire surface of the plant evenly and periodically, has been reported by Jamilah et al.(2015).The popular liquid organic fertilizer comes from shrubs and agricultural waste. Besides cleaning the environment, it also plays a role in inserting these materials into the food chain in nature. The use of *Chromolaena odorata* as LOF (Crocober plus and Unitas Super) has been successful in various crops of rice, corn, soybeans, vegetables, and fruits (Jamilah & Permana, 2015; Jamilah, Fadhila, & Mulyani, 2017). However, aside from *C. odorata*, many other shrubs can be used as the main ingredients for LOF, including *Tithonia diversifolia*. This plant has been reported to increase the yield of upland rice by 13.33% (Jamilah & Juniarti, 2015). *T. diversifolia* has a high content of N and K, so it can be used as material for making fertilizers. The advantages of these two types of shrubs are that they are resistant to pruning and quickly recover their growth, and they are easy to produce large clumps.

Tithonia as the main ingredient of LOF, which increased 13.33% of paddy field rice, has been reported by Jamilah, Maradona, Zahanis, & Ernita (2014).The combination of *C. odorata* and Tithonia is suitable for manufacturing LOF equipped with *Trichoderma* sp. There is no information on the effectiveness of all these ingredients on food crops. Therefore, the manufacture of LOF is necessary. In addition to reducing the purchase of artificial fertilizers, LOF also overcomes the shortage of nutrients in plants. Liquid organic fertilizer contains macro and micronutrients, so it is very suitable as a complementary fertilizer with expensive artificial fertilizers.

Soybean yields in Sumatra are significantly low, with an average of only 1.25 tons ha^{-1} compared to production in Java, which can reach 1.6 tons ha^{-1}(BPS, 2021). Soybean production in the United States is 34 bushels per acre or equivalent to 2.13 tons ha^{-1} (Brumm, 2003), making them an exporter of soybeans, including to Indonesia. The problem of low soybean yields in Indonesia is caused by, among others, low soil fertility (especially Ultisols), limited availability of artificial fertilizers, and many pests and diseases. It should be noted that the demand for soybeans in Indonesia is very high. Indonesia imports 70% of its domestic soybean needs (Satria, 2015). The use of superior varieties such as Mutiara-1 (BATAN, 1998)is very beneficial because of the large grain size and high yield per hectare (3.5 tons ha^{-1}). Therefore, applying LOF to soybean cultivation in West Sumatra is necessary. The purpose of this study was to determine the effects of LOF enriched with *Trichoderma* sp. on the levels of N, P, K and yield of Mutiara-1 soybean in Ultisol.

MATERIALS AND METHODS

The experiment was conducted on dry land with a pH of 4.66 (acidic) in Kuranji Village, Kuranji District, Padang.This experiment used various main ingredients to manufacture liquid organic fertilizer (LOC), including *C. odorata*, *T. diversifolia*, manure, coconut fiber, local microorganisms, and *Trichoderma* sp. The experiment was arranged in a factorial, completely randomized design, consisting of two factors. The first factor was the doses of *Trichoderma* sp. inoculants, which were 0, 1, and 2 kg for every 20 kg of the fermented main ingredients of the LOF. The second factor was the type of LOF based on the composition of the main ingredients, consisting of no LOF, Crocober (*C. odorata* + Coconut Coir + Manure + MOL), and Tithocroco (*T. diversifolia* + *C. odorata* + Coconut husk + Manure + MOL). The data obtained were analyzed using ANOVA with a significance level of 5%. The data showing significant differences between treatments were tested using LSD with a significance level of 5% (Steel & Torrie, 1980). The observations were made on plant N, P, and K levels, the weight of 100 seeds, number of pods per plant, pithy pods, and dry seed weight per plot and per hectare. P analysis was performed using the wet ashing method with H2SO4 and H2O2, then the extract was read on a spectronic device, and K was determined using the AAS tool (Eviati & Sulaeman, 2009).

LOF was prepared based on the same ratio except for local microorganisms (MOL). The compositions of the ingredients were Crocober (*C. odorata* + Coconut Coir + Manure + MOL) and Tithocroco (*T. diversifolia* + *C. odorata* + Coconut husk + Manure + MOL) (Jamilah & Novita, 2016) (Jamilah& Ben, 2018). All the determined main ingredients were finely chopped, stirred, and fermented for two weeks in a humid atmosphere by covering them tightly. Local microorganisms were made by crushing papaya fruit waste into old coconut water fermented using sugar for two weeks. The fermented main ingredient of LOF was added with 1 kg or 2 kg of *Trichoderma* sp. in 20 kg of mixed ingredients as the forerunner to LOF. Groundwater was then added, with a ratio to LOF of 1:1. The fertilizer was fermented again for two weeks in a tightly closed container. LOF was harvested after the aroma disappeared, which was indicated by the darkened color.

Soybean seeds were planted two seeds in each planting hole with a spacing of 20 x 25 cm on a plot measuring 2 x 2 m. The soil was pulverized, and two weeks before planting, liming using dolomite equal to 1 x Aldd was carried out. The basic fertilizers given were 50 kg Urea, 100 kg SP36, and 100 kg KCl per hectare, which were applied ten days after planting. The LOF was applied on soybean plants by taking every 50 ml of LOF solution dissolved in 1 liter of water and sprayed evenly and smoothly over the plant shoots. LOF application was carried out every other week and stopped when the plants started filling pods. From the results of this activity, LOF was applied to plants only three times.

Pest and weed were difficult to control because the intensity of the rain was too high. Plants (two clumps/plots) were destroyed 43 days after planting to determine plant N, P, and K levels and shoot dry weight. The remaining plants were kept until harvest. Crops are ready to harvest when the pods become yellowish and hard.

RESULTS AND DISCUSSION

The NPK levels were determined at the end of the vegetative growth phase (Figure 1). The NPK levels in soybean plants during the lower primordia phase were generally more influenced by the type of LOF than by *Trichoderma* sp. or the combination of both. The impact of *Trichoderma* sp. was not significantly able to increase the P and K levels, but there was an effect on the N levels of plants.

The N, P, and K levels were higher in the plants treated with Crocober. Meanwhile, the lowest level of N was observed in the plants without LOF application. The impact of LOF on the P and K levels was not significantly different. Plants absorb N, P, K, and other elements. However, the N, P, and K elements are classified as macro elements needed by plants. Nutrient levels of these plants will then affect the growth and yield of soybean plants. Compared to the P and K content of soybeans cultivated

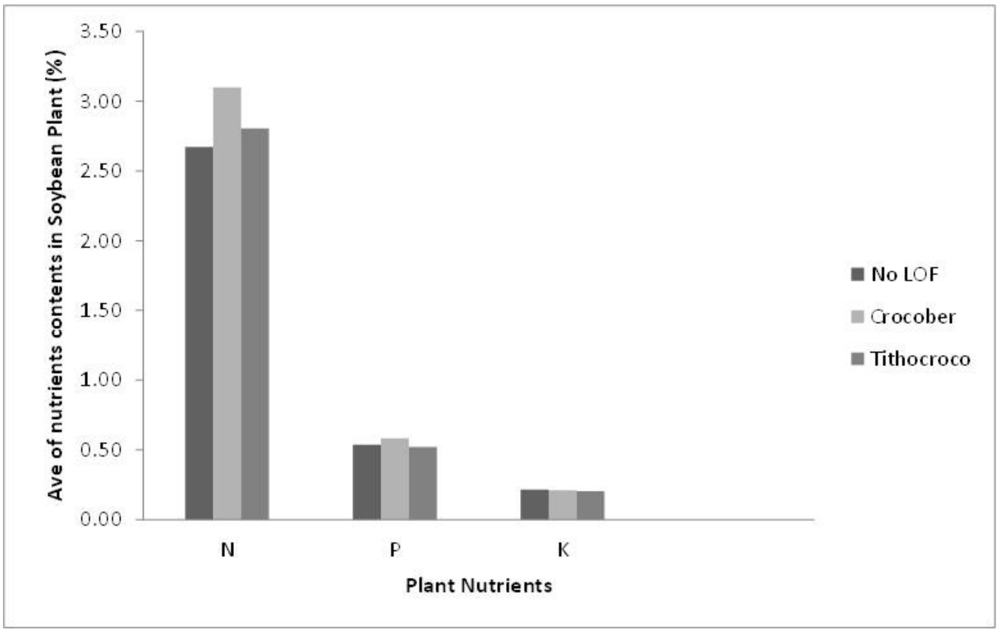

Figure 1. NPK levels in soybean plants at 43 days after planting

in Lampung, the P level in soybeans was higher in West Sumatra, but the mean level of K (<0.5%) was much lower than in Lampung (0.6-0.8%) (Wijanarko & Taufiq, 2004). Plants with sufficient N, P, and K nutrients will produce optimal metabolic activity. N is important in increasing the amount of leaf chlorophyll so that the N assimilation activity is optimal, producing high organic matter.

There was an interaction effect of LOF and *Trichoderma* sp. on the plant N level and shoot dry weight at 43 days after planting (Table 3). In general, the addition of 1 kg of *Trichoderma* sp. inoculants for every 20 kg of LOF main ingredients was able to increase 1% of plant N levels. However, if the dose of *Trichoderma* sp. inoculant increased again, plant N levels did not increase. The application of Crocober was able to increase plant N level compared to Tithocroco.

The addition of *Trichoderma* sp. significantly increases the effectiveness of LOF in improving plant growth. This is because *Trichoderma* sp. can produce hydrolysis enzymes, glucanase, proteases, and chitinase (Gómez, Chet, & Herrera-Estrella, 1997). The enzyme will accelerate the decomposition of organic matter contained in the LOF so that it is easy to mineralize, releasing ions such as NO_3^{-1}, K^+, and HPO_4^{2-}. Plants can immediately absorb these ions. Nutrients maximally absorbed by plants during the growth phase will increase the number of soybean pods. Even if given 2 kg of *Trichoderma* sp. inoculants, Tithocroco could produce the highest number of pods compared to other treatments.

Table 1 shows the interaction effect of *Trichoderma* sp. and LOF on N level and dry weight of plant crown per clump. N level was influenced more by the interaction of LOF and *Trichoderma* sp., as explained above. Crocober was superior in producing the highest N levels in plants, either with or without the addition of *Trichoderma* sp. The high nutrient content in the plant material will be translocated to the storage section or seeds during the seed filling phase. Photosynthate produced by the green part of the plant will be translocated into storage media, either in seeds, stem, roots, or leaves as sinks (Oosterhuis, 2009; Setiawan, Rosadi, & Kadir, 2014; Tanah & Penelitian, 2005; Tan, 2013).

Plants treated with the addition of 2 kg of *Tricho-*

Table 1. The results of the interaction test of Trichoderma sp. and LOF on N levels and shoot dry weight of soybean plants per clump

Type of LOF	Application of Trichoderma sp. (kg/20 kg of the LOF's main ingredient) inoculants					
	N level (%)			Shoot dry weight per clump (g)		
	0	1	2	0	1	2
Without LOF	1.96 Bc	3.22 Aa	2.84 Ab	13.00 Ab	18.22 Aa	14.56 Bb
Crocober	3.33 Aa	3.07 Aab	2.91 Ab	14.14 Aa	14.36 Ba	17.15 Aa
Tithocroco	2.98 Aa	3.12 Aa	2.32 Bb	12.15 Ab	17.25 ABa	19.51 Aa

Remarks: Means followed by the same letters in the same column are not significantly different according to LSD test at 5%.

Table 2. Effects of the doses of Trichoderma sp.for every 20 kg of LOF main ingredients on the number of pods

Doses of Trichoderma sp.(kg/20 kg LOF main ingredients)	Number of pods per clump
0	32.81 B
1	33.82 B
2	37.48 A

Remarks: Means followed by the same letters in the same column are not significantly different according to LSD test at 5%.

Table 3. Effects of LOF on the number of filled pods and weight of 100 seeds

Type of LOF	Number of filled pods (%)	Weight of 100 seeds (g)
Without LOF	83.14 A	22.31 A
Crocober	82.69 AB	21.64 A
Tithocroco	79.19 B	20.88 A

Remarks: Means followed by the same letters in the same column are not significantly different according to LSD test at 5%.

Table 4. Effects of the addition of Trichoderma sp. to LOF on the weight of dry seeds at a moisture content of 14%

Type of LOF	Application of Trichoderma sp. (kg/20 kg of the LOF's main ingredient) inoculants					
	Weight of dry seeds at a moisture content of 14% (g plot-1)			Weight of dry seeds at a moisture content of 14% (ton ha-1)		
	0	1	2	0	1	2
Without LOF	919.88Aab	912.92Ab	1082.31Ba	2.29	2.28	2.70
Crocober	967.38Aa	1009.84Aa	946.13Ba	2.42	2.52	2.36
Tithocroco	925.03Ab	912.94Ab	1268.88Aa	2.31	2.28	3.17

Remarks: Means followed by the same letters in the same column are not significantly different according to LSD test at 5%.

derma sp. for every 20 kg of LOF main ingredients produced a higher number of pods (Table 2). The higher doses of *Trichoderma* given will increase the number of pods per clump. There was no significant effect of LOF on the number of soybean pods per clump, but a significant effect on rice pods was observed. This proves that LOF is a nutrient needed by plants for filling their pods.

The number of filled pods and the weight of 100 seeds were not affected by the application of LOF and *Trichoderma* sp. (Table 3). The weight of 100 seeds was not affected by fertilization but was more determined by plant genetics.Based on BATAN (1998) and Riniarsi (2015),the weight of 100 seeds of soybean cv. Mutiara-1 reached 23.2 g, much larger than that of other varieties, which were only around 8.36 g for the Tanggamus and Sibayak varieties(Wijanarko & Taufiq, 2004). The weight of 100 seeds in this study did not match the description of the Mutiara-1 variety, which is likely because the nutrients received by soybean plants are still not optimal because the weight of 100 seeds has the potential to be increased again.

There was an interaction effect of LOF and inoculants on the weight of dry seeds at a moisture content of 14%. The highest dry seed production was observed in the plants treated with the addition of 2 kg of *Trichoderma* sp. inoculants in every 20 kg of Tithocroco (Table 4). All types of LOC without *Trichoderma* sp. resulted in the lowest dry seed production. This result shows that adding *Trichoderma* sp. to the LOF is important. Its impact has been proven on the uptake of N, P, and K nutrients, which subsequently affect the vegetative growth and ultimately increase the production of dry seeds.

In general, the addition of *Trichoderma* sp. to all LOF treatments gave high seed yields. The addition of 2 kg of Trichoderma/20 kg of the main ingredient of Tithocroco was able to produce the highest seed weight, reaching 3.17 tons ha^{-1}. Plants only given *Trichoderma* sp. produced the lowest dry seed weight. However, the combination treatment of 2 kg of *Trichoderma* sp. inoculants with 20 kg of Tithocroco produced the highest dry seed weight, reaching 3.17 tons ha^{-1}, which was increased by 38.42% compared to plants without LOF and *Trichoderma* sp.

CONCLUSION

From the experimental results, it can be concluded that the addition of 2 kg of *Trichoderma* sp. inoculants in every 20 kg of Tithocroco resulted in the highest dry seed production, reaching 3.17 tons ha^{-1}, increased by 38.42% compared to those not given with LOF.

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REFERENCES

BATAN. (1998). Kedelai Varietas Unggul Baru Hasil Pemuliaan Mutasi Radiasi. (P. D. I. Nuklir, Ed.). Jakarta: Batan.

BPS. 2021. Analisis produktivitas jagung dan kedelai di Indonesia 2020 (Hasil Survei Ubinan). Penerbit BPS-RI.

Brumm, T. J. (2003). Quality of the 2003 Soybean Crop in the United States. Agricultural and Biosystems Engineering, 1(2), 2–18.

Chamzurni, T., Sriwati, R., & Selian, D. (2011). efektivitas dosis dan waktu aplikasiTrichoderma virens TERHADAP serangan Sclerotium rolfsiipada kedelai.Floratek, 6(1), 62–73.

de Oliveira, J. A. M., Nurdin, M., & Suskandini, R. D. (2014). penggunaanTrichoderma sp. sebagai agensia pengendalian terhadapPyricularia oryzae Cav. penyebab blas pada padi. J. Agrotek

Tan. K.H. (2013). Humo-Nanotube Membrane Relation With Biopolymers. In Journal of Chemical Information and Modeling (Vol. 53, pp. 1689–1699). Department of Crops and Soil Science The University of Georgia, Athens, GA, USA PREFACE. https://doi.org/10.1017/CBO9781107415324.004

Eviati, & Sulaeman. (2009). Analisis Kimia Tanah, Tanaman, Air dan Pupuk. (B. H. . Prasetiyono & D. Santoso, Eds.) (2nd ed.). Bogor: Balai Penelitian Tanah, Bogor.

Gómez, I., Chet, I., & Herrera-Estrella, A. (1997). Genetic diversity and vegetative compatibility among Trichoderma harzianum isolates. Molecular and General Genetics, 256(2), 127–135. https://doi.org/10.1007/s004380050554

Jamilah& Ben Kurniawan, Z. (2018). Pengaruh pupuk organik cair UNITAS SUPER asal Chromolaena odorata terhadap pertumbuhan dan hasil padi hitam (Oryza sativa L .). Jurnal Agroteknologi, 8(2), 15–20.

Jamilah, Ediwirman, & Ernita, M. (2015). the Effect of Fermented Liquid Organic Fer- Tilizer and Potassium for Nutrient Uptake and Yield of Rice At Tropical Upland. J. Environ.Res.Develop., 9(4), 1–6.

Jamilah, Fadhila, R., & Mulyani, S. (2017). Farm analysis of rice crop trimmed periodically in the tropical wet. In International Conerence on Social, Humanities and Government Science (Vol. 1, p. 631). https://doi.org/10.1016/S0969-4765(04)00066-9

Jamilah, & Juniarti. (2015). Potensi Tanaman Padi Dipangkas Secara Periodikuntuk Pakan Ternak Pada Metoda Budidaya Integrasi Padi Ternak Menunjang Kedaulatan Pangan Dan Daging. :aporan Penelitian Fakultas Pertanian Univ. Tamansiswa, Padang (Vol. 53). Padang.

Jamilah, Maradona, C., Zahanis, & Ernita., M. (2014). Penetapan konsentrasi dan nterval pemberian POC asal sabut kelapa dan thitonia untuk meningkatkan hasil padi ladang (Oriza sativa L.). In Pros.Sem.Nas. Politani Payakumbuh, Sumatera Barat (Vol. 1, pp. 53–62). Payakumbuh, Sumatera Barat: Politeknik Pertaian Negeri Payakumbuh.

Jamilah, & Novita, E. (2016). Pengaruh Pupuk Organik Cair Crocober Terhadap Tanaman Bawang Merah (Allium ascalonicum L.).

Jurnal Ipteks Terapan, 2(2), 67–73.
Jamilah, & Permana, D. (2015). Aplikasi pupuk organik cair asal C.odorata + sabut kelapa dan asam humat untuk tanaman Stroberi (Fragaria ananassaa). Prosiding Seminar Nasional Ketahanan Pangan Dan Pertanian Berkelanjutan Politeknik Pertanian Negeri Payakumbuh, 31–36.
Oosterhuis, D. (2009). Foliar fertilization: mechanisms and magnitude of nutrient uptake. Proceedings of the Fluid Forum, 15–17.
Putri, L. A., Jamilah, Widodo H. (2018). Pengaruh pupuk organik cair dan Trichoderma sp terhadap pertumbuhan dan hasil melon (Cucumis melo). Jurnal Bibiet, ISSN 2502-0951, 3(1), 17–24.
Riniarsi, D. (2015). Kedelai. Jakarta: Pusat Data dan Sistem Informasi Pertanain Kementerian Pertanian.
Rizal, S., & Susanti, T. D. (2018). Peranan Jamur Trichoderma sp yang Diberikan terhadap Pertumbuhan Tanaman Kedelai (Glycine max L .). Sainmatika, 15(1), 23–29. https://doi.org/10.31851/sainmatika.v15i1.1759
Satria. (2015). Produksi Kedelai Nasional Masih Rendah. Jogya karta.
Setiawan, W., Rosadi, B., & Kadir, M. Z. (2014). (Glycine max [L] Merr .) Pada Beberapa Fraksi Penipisan Air Tanah Tersedia Response Of Growth And Yield Of Three Variety Of Soybean (Glycine max [L] Merr .) on some available soil water depletions, Jurnal Teknik pertanian Lampung3(3), 245–252.
Steel, R. G. D., & Torrie, J. H. (1980). Principles and Procedures of Statistics: A Biometrical Approach. Biometrics, 37(4), 859. https://doi.org/10.2307/2530180
Tanah, B. P., & Penelitian, B. (2005). Analisis Kimia Tanah , Tanaman , Air , Dan Pupuk. Balai Penelitian Tanah Badan Penelitian dan Pengembangan Pertanian Departemen Pertanian.
Wijanarko, A., & Taufiq, A. (2004). Pengelolaan Kesuburan Lahan Kering Masam Untuk Tanaman Kedelai. Bulletin Palawija, 50(7), 39–50.