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# Combination of *Pseudomonas fluorescens* and Liquid Organic Fertilizer on Growth and Production of Peanut (*Arachis hypogaea* L.)

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Excessive and continuous use of synthetic chemicals results in a decrease in soil fertility, thereby reducing peanut production. Minimizing the use of synthetic chemicals can be done through the application of liquid organic fertilizers. This study aims to examine the use of *Pseudomonas fluorescens* and liquid organic fertilizer in the growth and production of peanuts (*Arachis hypogaea* L.). This research uses a factorial RBD with two factors. The first factor was the concentration of P. fluorescens, which consisted of 0 ml.l$^{-1}$, 10 ml.l$^{-1}$, 15 ml.l$^{-1}$, and 20 ml.l$^{-1}$. The second factor was the concentration of liquid organic fertilizer, consisting of 0 ml.l$^{-1}$, 100 ml.l$^{-1}$, and 250 ml.l$^{-1}$. The results showed that the P. fluorescens 15 ml.l$^{-1}$ treatment showed significant results in stem diameter (6.03 mm), number of root nodules (141.83), fresh biomass weight (355.97 g), dry biomass weight (75.87 g), fresh pod weight (62.39 g), dry pod weight (37.00 g), the total number of pods (25.30), and number of pithy pods (20.51). In the treatment of liquid organic fertilizer, 100 ml.l$^{-1}$ showed significant results in fresh biomass weight (315.69 g), dry biomass weight (66.97 g), fresh pod weight (55.21 g), dry pod weight (32.82 g), number of pithy pods (17.60), and seed weight per sample with an average production yield of 17.01 g/sample (2.7 tons/ha). The use of P. Fluorescens and liquid organic fertilizer simultaneously showed no interaction with all observed variables.

Key words: concentration, liquid organic fertilizer, peanut, *Pseudomonas fluorescens*

Penggunaan bahan kimia sintetik yang berlebihan dan terus menerus mengakibatkan penurunan kesuburan tanah sehingga menurunkan produksi kacang tanah. Meminimalkan penggunaan bahan kimia sintetik dapat dilakukan melalui aplikasi pupuk organic cair. Penelitian ini bertujuan untuk mengkaji penggunaan *Pseudomonas fluorescens* dan pupuk organic cair dalam pertumbuhan dan produksi kacang tanah (*Arachis hypogaea* L.). Penelitian ini menggunakan RBD factorial dengan dua faktor. Faktor pertama adalah konsentrasi *P. fluorescens* yang terdiri dari 0 ml.l$^{-1}$, 10 ml.l$^{-1}$, 15 ml.l$^{-1}$, dan 20 ml.l$^{-1}$. Faktor kedua adalah konsentrasi pupuk organic cair yang terdiri dari 0 ml.l$^{-1}$, 100 ml.l$^{-1}$, dan 250 ml.l$^{-1}$. Hasil penelitian menunjukkan perlakuan *P. fluorescens* 15 ml.l$^{-1}$ menunjukkan hasil nyata pada diameter batang (6,03 mm), jumlah bintil akar (141,83), berat biomassa segar (355,97 g), berat biomassa kering (75,87 g), bobot polong segar (62,39 g), bobot polong kering (37,00 g), jumlah polong total (25,30), dan jumlah polong bernas (20,51). Pada perlakuan pupuk organic cair 100 ml.l$^{-1}$ menunjukkan hasil nyata pada berat biomassa segar (315,69 g), berat biomassa kering (66,97 g), berat polong segar (55,21 g), berat polong kering (32,82 g), jumlah polong bernas (17,60), dan berat biji per sampel dengan rata-rata hasil produksi 17,01 g/sampel (2,7 ton/ha). Penggunaan *P. fluorescens* dan pupuk organic cair secara simultan menunjukkan tidak adanya interaksi dengan semua variabel pengamatan.

Kata kunci: kacang tanah, konsentrasi, pupuk organik cair, *Pseudomonas fluorescens*

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In Indonesia, the need for peanuts continues to increase along with the increase in population. Peanuts have high economic value and are rich in nutritional components, namely protein, and fat. Peanut productivity in Indonesia has decreased. The average productivity of national peanuts from 2008 to 2012 experienced a slight increase. Data from the Central Bureau of Statistics stated that peanut productivity in 2008 was around 1.21 tons/ha, in 2012 it increased to 1.26 tons/ha. Peanut productivity in Indonesia is relatively low, when compared to the USA, China and Argentina, which have reached more than 2 tons/ha. The increase in peanut productivity in Indonesia has not been followed by an increase in peanut production, the national peanut production is still relatively low, even from 2008 to 2012 it continued to decline. In 2008 peanut production was around 770.054 tons, and in 2012 it was around 709.063 tons (Rizal *et al.* 2017). Peanut production tends to fluctuateactively so domestic peanut needs must be met by imports. To reduce the import of peanuts, the effort that needs to be

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done is to increase the production of peanuts.

The problem that causes a decrease in peanut production is low soil fertility caused by excessive and continuous use of synthetic chemicals which can reduce the nutrient content in the soil and damage the soil texture which is very important in the growth of peanut plants. Based on the results of soil tests on the research area at AIAT East Java, it is known that the C-Organic content is 3.02% and the nitrogen content is 0.41%, which are classified as medium criteria. The content of P2O5 is 132 mg/100 g and K2O is 205 mg/100 g, which are classified as very high criteria resulting from the residual use of chemical fertilizers from previous crop cultivation. Increasing C-Organic in the soil can be done through balanced fertilization and the addition of organic materials, so that soil fertility can be maintained and sustainable (Bahagia *et al.* 2022). Utilization of household waste is not optimal, so there needs to be a treatment so that it can become something useful.

Liquid organic fertilizer is an innovation that can reduce household waste. Liquid organic fertilizers are used more effectively because they are liquid and dissolve easily in the soil (Yusnaeni, 2021). The advantages of liquid organic fertilizer are that it is easily absorbed by plant roots due to its fast release, its application is easy because it can be sprayed on plants or soil, and the raw material for making POC is easy to get because it can be made from natural ingredients or household waste, and can improve biological properties, soil chemistry, and soil physics. Liquid organic fertilizer contains nitrogen, potassium, and phosphorus, which are difficult for plants to absorb. Thus it is necessary to have bacteria that can dissolve phosphorus so that it can be absorbed by plants.

*Pseudomonas spp* bacteria are bacteria that can colonize the rhizosphere which functions as a biofertilizer, can optimize nutrient absorption, can fix N from the air, and can dissolve phosphorus nutrients to form mineral ions that are easily absorbed by plants (Nosheen *et al.* 2021).

*P. putida* and *P. fluorescens* enhance the nodulation, nitrogen fixation and green bean performance in combination with R.leguminosarum bv. phaseoli; but as the results show P.fluorescens B119 has the highest phosphate solving power (Behnam *et al.* 2013).

Deepek and Satyafir (2011) show that *Pseudomonas* strains comparatively increased the root growth at 10 days than to 5 days observation of legume plants. Similar results were obtained when cuttings of sour cherry (Prunus cerasus) and black-currant (Ribes nigrum) were inoculated with a recombinant strain of *Pseudomonas fluorescens* that produced increased amount of IAA.

Based on the existing problems, it is necessary to find out the properuse of P. Fluorescens and liquid organic fertilizer, which is expected to increase the growth and production of peanuts.

## MATERIALS AND METHODS

***Materials.*** The tools used in this study were hoes, digital scales, knapsacks, buckets, plastic, *kenco*, stirrers, sickles, roll meters, measuring cups, hoses, plastic drums, and filters.The materials used in this study were peanut seeds of the Hypoma 1 varieties, *P.fluorescens*, markers, plastic, label paper, banana peels, bamboo leaves, moringa leaves, lamtoro leaves, molasses, EM4, rice washing water, clean water, pesticides, and manure.

***Production of LOC and Land Preparation.*** Liquid Organic Fertilizer is made from banana peels, moringa leaves, bamboo leaves, lamtoro leaves, molasses, rice washed, clean water, and EM4. The ingredients are mixed and fermented for 7-14 days in an airtight state. Furthermore, land processing was carried out by loosening the soil with a hoe, and then the soil was made into beds with a size of 1 x 1.5 m as many as 36 beds. Using a distance between plots of 30 cm and a distance between blocks of 1 meter. Basic fertilizer application is done after one week of planting. Then spraying *P. fluorescens* on the soil surface according to the concentration of the treatment being tested. The calculation of the bacterial concentration begins with the calculation of the concentration or density at 30 x 10-7 CFU. Next, 1 ml of the solution containing the bacteria was taken to be dissolved according to the specified volume, namely 10 ml/L, 15 ml/L, and 20 ml/L.

***Planting and Maintenance.*** The Hypoma 1 variety of peanuts was planted by digging. Seeds were planted using a spacing of 40 x 20 cm. Plant maintenance includes replanting, watering, weeding, heaping, fertilizing, and pest and disease control. Stitching is done if the plant does not grow or has abnormal growth. Watering is done in the morning or evening.Weeding and hilling are done when the peanut plants are 15 HST and 35 HST.

***Fertilization.*** Fertilization of liquid organic fertilizer was carried out when the peanuts were 14 HST, 28 HST, and 42 HST according to the concentration of the treatment.

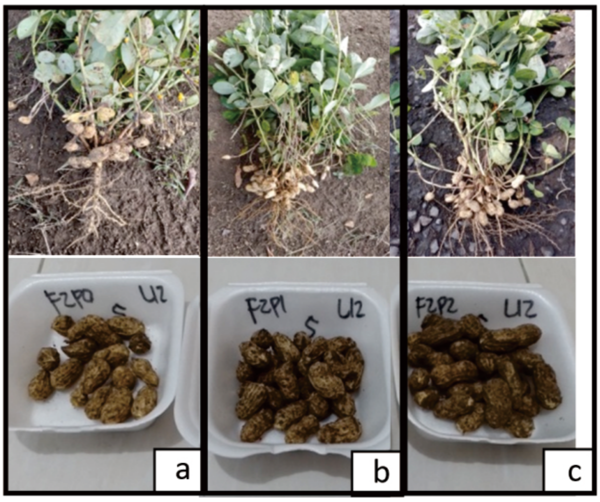


Fig 1 Pod yield at P. fluorescens concentration of 15 ml/L at (a) POC concentration of 0 ml/L, (b) POC concentration of 100 ml/L, and (c) POC concentration of 250 ml/L.

***Disease and Pest Control.*** Control of pests and diseases on peanut plants using active pesticides containing 106 g/l cyhalothrin lambda and 141 g/l "thiamectoxane" with the recommended dosage.

***Harvesting.*** Harvesting peanuts when the plant stems harden, some of the leaves are yellow and some of the leaves fall, the peanut pods are hard, and are full when held.

***Observational Variables.*** The observed variables included stem diameter, number of root nodules, the weight of fresh biomass, the weight of dry biomass, fresh pod weight, dry pod weight, total pod number, number of fruitful pods, number of empty pods, the weight of seed per sample, and weight of 100 seeds.

***Experimental design.*** The study was designed with a factorial Randomized Block Design (RBD). The first factor was the concentration of *P. fluorescens* with 4 levels: F0 (0 ml/l), F1 (10 ml/l), F2 (15 ml/l), and F3 (20 ml/l) with concentration 30 x 10-7 CFU per ml. The second factor was the concentration of liquid organic fertilizer with 3 levels, namely: P0 (0 ml/l), P1 (100 ml/l), and P2 (250 ml/l). Repeated 3 times so that there are 36 experimental units.

***Data Analysis.*** Observational data were analyzed using ANOVA. If there is a significant effect, then Duncan's Multiple Range Test (DMRT) is performed.

## RESULTS

The results of the data showed that the single treatment of *Pseudomonas fluorescens* and liquid organic fertilizer affected the observed variables tested. The use of *Pseudomonas fluorescens* had a significant effect on stem diameter and the number of root nodules presented in Table 1.

The application of *P. fluorescens* showed significant results on stem diameter at a concentration of 15 ml/l, while the number of root nodules was affected by concentrations of 10 ml/l and 15 ml/l. Meanwhile, LOC fertilizer itself did not show a significant effect on stem diameter and the number of root nodules. In addition, it is known that there is no interaction between the use of P. fluorescens and LOC on stem diameter and root nodules.

The *P. fluorescens* and LOC treatments had a single effect on stem diameter and the number of root nodules.

The weight of biomass, pod weight, and the number of pods showed that the treatment of P. Fluorescens and liquid organic fertilizer had a significant effect as presented in Table 2 and Fig 1.

There is an interaction between *P. fluorescens* and LOC administration on wet biomass weight, dry biomass weight, fresh pod weight, dry pod weight, number of total pods, number of pods filled. But it doesn't interact with the number of empty pods.

*P.fluorencens* together with LOC had a very significant effect on fresh pod weight and dry pod weight. *P.fluorescens* with concentrations of 15 ml/l and 20 ml/l and LOC 250 ml/l had a very significant effect on fresh pod weight. Meanwhile, a very significant effect on dry pod weight was found in the combination of *P.fluorencens* 15 ml/l and LOC 250 ml/l.

The significant effect of the combination of *P.fluorescens* and LOC was found on wet biomass weight, dry biomass weight, number of total pods, and number of pods filled. The optimal concentration was

Table 1 Average stem diameter and number of root nodules in the treatment of *P. fluorescens* and liquid organic fertilizer

| Treatment | Stem Diameter (mm) | Numberof Root Nodules |
|---|---|---|
| *P. fluorescens* (ml/l) | (**) | (**) |
| 0 | 5,61 b | 119,27 b |
| 10 | 5,63 b | 140,00 a |
| 15 | 6,03 a | 141,83 a |
| 20 | 5,82 ab | 131,26 ab |
| LOC (ml/l) | (ns) | (ns) |
| 0 | 5,72 | 131,38 |
| 100 | 5,76 | 130,80 |
| 250 | 5,84 | 137,08 |

Table 2 Average biomass weight, pod weight, and number of pods in the treatment of *P. fluorescens* and liquid organic fertilizer

| Treatment | Wet Biomass Weight (g) | Dry Biomass Weight (g) | Fresh Pod Weight (g) | Dry Pod Weight (g) | Number of Total Pods | Number of Pods Filled | Number of Empty pods |
|---|---|---|---|---|---|---|---|
| *P. fluorescens* (ml/l) | (**) | (**) | (**) | (**) | (*) | (**) | (*) |
| 0 | 279,44 b | 57,88 b | 49,08 b | 31,13 b | 21,08 b | 15,06 b | 6,03 a |
| 10 | 296,16 ab | 64,46 ab | 51,51 b | 30,49 b | 23,31ab | 18,09ab | 5,22 b |
| 15 | 355,97 a | 75,87 a | 62,39 a | 37,00 a | 25,30 a | 20,51 a | 4,79 b |
| 20 | 317,87 ab | 70,20 ab | 60,04 a | 31,30 b | 23,29ab | 18,57ab | 4,72 b |
| LOC (ml/l) | (*) | (*) | (**) | (**) | (*) | (*) | (ns) |
| 0 | 281,81 b | 61,77 b | 51,51 b | 28,92 b | 22,37 b | 16,76 b | 5,61 |
| 100 | 315,69 ab | 66,97 ab | 55,21 ab | 32,82 ab | 22,42 b | 17,60ab | 4,82 |
| 250 | 339,58 a | 72,57 a | 60,54 a | 35,70 a | 24,95 a | 19,81 a | 5,14 |

Annotation: The numbers followed by the same lower case letters are not significantly different based on the DMRT Test level of 5% (*) and 1% (**)

Table 3 Seed weight per sample and weight of 100 seeds on treatment of *P. fluorescens* and liquid organic fertilizer

| Treatment | Seed Weight Per Sample (g) | Weight 100 Seeds (g) |
|---|---|---|
| *P. fluorescens* (ml/l) | (ns) | (ns) |
| 0 | 16,32 | 67,56 |
| 10 | 16,91 | 68,67 |
| 15 | 17,76 | 71,00 |
| 20 | 16,52 | 68,00 |
| LOC (ml/l) | (*) | (ns) |
| 0 | 14,43 b | 65,92 |
| 100 | 17,01 ab | 69,17 |
| 250 | 19,20 a | 71,33 |

obtained from the combination of *P. fluorescens* 15 ml/l and LOC 250 ml/l.

The addition of *P. fluorenscens* and LOC did not effect on the number of empty pods. It is known that the administration of *P.fluorescens* to the control plants (untreated) showed a higher number of empty pods than the plants which were given the addition of *P.fluorescens*.

The average seed weight per sample and the weight of the 100 seeds are presented in Table 3. There was no interaction between administration of *P.fluorescens* and LOC on the seed weight per sample and the weight of 100 seeds. Giving a single LOC of 250 ml/l only affects the seed weight per sample.

## DISCUSSION

The treatment of *P. fluorescens* had a significant effect on the diameter of peanut stems and the number of root nodules. This is because *P. fluorescens* can fix N in the air and dissolve phosphorus nutrients. *P. fluorescens* bacteria can increase plant growth by fixing nitrogen, dissolving phosphate, and producing phytohormones (Anderson, 1955). N and P elements are important for plant vegetative growth such as stem diameter. Elements N and P are involved in the formation of energy and amino acids which play a role in plant growth and development. Phosphorus elements are absorbed by plants in the form of H2PO4- and HPO42- ions (Oktaviani *et al.* 2014). If the need for elements in the soil is fulfilled, the metabolic processes and accumulation of plant assimilate in the stem increases, resulting in larger stems in peanut plants (Jiahui *et al.* 2021).

In the number of root nodules, it is suspected that N and P elements play a role in the formation of root nodules. Element P plays a role in the growth of plant roots. The availability of the P element is because these bacteria live around the rhizosphere (Oktaviani *et al.* 2014). The percentage of the number of root nodules with N fixation is related to the leghemoglobin content in the effective nodule (Ryosuke *et al.* 2015). The increase in the number of root nodules is in line with the number of bacteria working to fix N and optimize P absorption.

The treatment of *P. fluorescens* and liquid organic fertilizer had a significant effect on the weight of peanut biomass. This is because if the nutrient content in the soil is sufficient, it can increase the growth of peanut plants. The availability of nutrients and hormones can stimulate cell division and photosynthetic results which affect the weight of plant biomass (Ahmad, 2016). Liquid organic fertilizer contains macronutrients that are very important for plant growth and development. The use of liquid organic fertilizer can add macro and micronutrients to the soil (Belen *et al.* 2016). These elements can be absorbed by plants in ionic form, thus the role of *P. fluorescens* bacteria can dissolve element P and fix N so that mineral ions can be formed which are easily absorbed by plants. *P. fluorescens* bacteria functions as a biofertilizer because it can dissolve phosphorus (P) bound to Fe, Al, Ca, and Mg elements into phosphate ions so that they can be absorbed by plant roots (Widiawati and Suliasih, 2006).

The weight of the peanut pods has a significant effect because the availability of nutrients in the soil is sufficient so that the filling of the pods can be optimal. If the N and P nutrients are sufficient, the absorption of nutrients and the process of photosynthesis can work properly, so that the photosynthate produced will affect the weight of thepods (Soelaksini *et al.* 2022). The weight of the pods planted is influenced by the number of empty pods and contents, if the number of empty pods is small, the pod weight will be relatively high (Hari, 2020).

The number of pods had a significant effect due to the treatment of *P. fluorescens* and liquid organic fertilizer. The availability of nutrients in the soil is optimal so that photosynthesis can run well. The assimilated results are distributed to plant parts including the peanut pods. The availability of nutrients in the soil affects the number of pods produced. The existence of empty pods is caused by competition in obtaining photosynthetic results with other plant organs. Thus if there are flowers that appear it is also suspected to result in empty pods (Hari, 2020). Adequate availability of nitrogen and phosphorus nutrients in the soil will reduce the percentage of empty pods and increase the weight and number of pods (Marlina and Gusmiatun, 2020).

Liquid organic fertilizer has a significant effect on the weight of the seeds per sample of peanuts. This is because the application of liquid organic fertilizer can add macronutrients such as N, P, and K. Element N is a constituent of organic matter in peanut seeds which includes amino acids, proteins, and other constituents of peanut seeds. So the addition of N can increase the dry weight of the seeds (Belen *et al.* 2016). Another factor in the treatment of *P. fluorescens* was not significantly different, presumably due to competition in obtaining photosynthetic results with other plant organs, such as empty pods.

The weight of 100 seeds showed that *P. fluorescens* and liquid organic fertilizer had no significant effect. This is thought to be due to genetic factors. The shape of the seeds and the weight of 100 seeds were influenced by the parent plant (Regina and Angela, 2005). The weight of 100 seeds is influenced by the original properties of the mother plant, but these properties depend on other components. Although the weight of the seeds and the number of pods are less, the size of the seeds is not much different from the plant it self (Ivers and Fehr, 1978). Another factor is thought to be competition in obtaining photosynthetic results with other plant organs such as empty pods (Hari, 2020).

The concentration of *P. fluorescens* 15 ml/l had a significant effect on stem diameter, number of root nodules, fresh biomass weight, dry biomass weight, fresh pod weight, dry pod weight, total pod number, and the number of pithy pods. The concentration of liquid organic fertilizer of 100 ml/l significantly affected the weight of fresh biomass, dry biomass weight, fresh pod weight, dry pod weight, number of full pods, and seed weight per sample with an average production yield of

17.01 g/sample (2.7 tonnes/ha). There was no interaction between the treatment of *P. fluorescens* and liquid organic fertilizer for all observed variables.

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## REFERENCES


Ahmad, F. 2016. The Influence of Media and Fertilization Intervals on the Growth of Clove Vigor (*Syzygum aromaticum* L.). Mitra Sains, 4 (4), 154307.Anderson, G. R. 1955. Nitrogen fixation by Pseudomonas-like soil bacteria. Journal of Bacteriology, 70(2),129-133.

Bahagia, M., Ilyas, I., & Jufri, Y. 2022. Evaluation of Soil Nutrient Content of Phosphorus (P) and C-Organic (C) in Three Intensive Paddy Field Locations in Aceh Besar District. Jurnal Ilmiah Mahasiswa Pertanian, 7 (2).

Behnam Tahmasebpour, Hassan Rezaei and Naser Aliasgharzadeh. 2013. The Effects Of Helping Bacteria (Pseudomonas Spp.) In Nitrogen Green Beans Fixation And Nodulation With *Rhizobium leguminosarum* By Phaseoli. International Journal of Science Invention Today (IJSIT), 2013, 2(6), 556-566

Bele´n Martı´nez-Alca´ntara, Mary-Rus Martı´nez-Cuenca, Almudena Bermejo, Francisco Legaz, Ana Quiñones. 2016. Liquid Organic Fertilizers for Sustainable Agriculture: Nutrient Uptake of Organic versus Mineral Fertilizers in Citrus Trees. PLOS ONE. DOI:10.1371/journal.pone.0161619 October 20, 2016

Deepak K. Malik and Satyavir S. Sindhu. 2011. Production of indole acetic acid by *Pseudomonas* sp.: effect of coinoculation with *Mesorhizobium* sp. Cicer on nodulation and plant growth of chickpea (*Cicer arietinum*). Physiol Mol Biol Plants (JanuaryMarch 2011) 17(1):2532.

Hari Soeseno Hardjoloekito. (2020). Dosage Effectiveness Of Manure And Planting Distance On The Growth And Production Of Peanuts (*Arachis hypogaea*, L). International Journal of Research - GRANTHAALAYAH, 8(8), 200-206. https://doi.org/10.29121/granthaalayah.v8.i8.2020.86 1

Ivers, D. R., & Fehr, W. R. 1978. Evaluation of the Pure-line Family Method for Cultivar Development 1. Crop Science, 18(4), 541544.

Jiahui Li, Yanlan Huang, Haochun Zha, Mengjie Yu, Weiqin Su, Huaihai Chen, Peng Leng, Jihui Li, Yu Luo, Yong Li, Zhongmin Dai, and Jianming Xu. 2021. Consistent responses of microbial C and N metabolic processes to elevated CO2 across global terrestrial ecosystems. Journal of Soils and Sediments (2022) 22:403408.

Marlina, N., & Gusmiatun, G. 2020. The Effectiveness of Bio Fertilizers to Increase Soybean Productivity in Lebak Land: Test the Effectiveness of Bio Fertilizers to Increase Soybean Productivity in Lebak Land. Agrosainstek: Jurnal Ilmu Dan Teknologi Pertanian, 4 (2), 129136.

Nosheen, S.; Ajmal, I.; Song, Y. Microbes as Biofertilizers, a Potential Approach for Sustainable Crop Production. Sustainability 2021, 13, 1868. https://doi.org/10.3390/su13041868

Oktaviani, D., Hasanah, Y., & Barus, A. 2014. Growth of soybean (*Glycine max* l. Merrill) with the application of arbuscular mycorrhizal fungi (FMA) and a microbial consortium. Agroekoteknologi, 2 (2).

Regina Lucia Ferreira Gomes and Ângela Celis de Almeida Lopes. 2005. Correlations and path analysis in peanut. Crop Breeding and Applied Biotechnology 5:105-112, 2005

Rizal Mahdi Kurniawan, Heni Purnamawati, and Yudiwanti Wahyu E.K. 2017. Growth Respond and Production of Peanut (*Arachis hypogaea* L.) to Deep Furrow Planting System and Application of Different Fertilizers. Bul. Agrohorti 5 (3) : 342-350 (2017)

Ryosuke Tajima, O New Lee, Jun Abe, Alexander Lux and Shigenori Morita. 2015. Nitrogen-Fixing Activity of Root Nodules in Relation to Their Size in Peanut (*Arachis hypogaea* L.). Plant Prod. Sci. 10(4) : 423 — 429 (2007), Published online: 07 Dec 2015

Soelaksini, L. D., Irawan, T. B., & Nuraisyah, A. 2022. Increasing Production of Mung Beans (*Vigna radiate* L) using *Azolla pinnata* Fertilizer and Urea Fertilizer. Jurnal Ilmiah Inovasi, 22(1), 7383.

Widiawati, Sri, & Suliasih, S. 2006. The population of phosphate solubilizing bacteria (PSB) from Cikaniki, Botol Mountain, and Ciptarasa Area, and the ability of PSB to solubilize insoluble P in solid pikovskaya medium. Biodiversitas Journal of Biological Diversity, 7(2).

Yusnaeni, Y. 2021. Development of Student Entrepreneurial Spirit Through Training on Making Household Waste Pocs. Jamaika: Jurnal Abdi Masyarakat, 2(1), 110.