# Response of provision of vermicompost fertilizer and Effective Microorganism (EM4) on the growth and production of Soybean (Glycine max L.)

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**ABSTRACT**

Soybeans are a type of legume that is the basic ingredient for various Asian foods such as soy sauce, tofu, and tempeh. The purpose of this study was to determine the response of vermicompost fertilizer and EM4 (Effective Microorganism) on the growth and production of soybean plants (Glycine max L.). This study used a factorial randomized block design (RBD) with 3 replications and 2 treatment factors. The first factor was the application of vermicompost fertilizer (K), they were K1 = 200 grams/plant, K2 = 300 grams/plant, K3 = 400 grams/plant, and K4 = 500 grams/plant. The second factor was EM4 (E), they were E0 = No treatment (Control), E1 = Concentration of 25 ml/liter of water, and E2 = Concentration of 50 ml/liter of water. The parameters measured were plant height, number of leaves, stem diameter, number of productive branches per plant, number of pods per plant, weight of pods per plant. Providing vermicompost fertilizer had a significant effect on all observed parameters. The best results in applying vermicompost fertilizer were at the K4 level with a dose of 500 g/plant in all observations. Giving EM4 had no significant effect on the growth and yield of soybean plants. The interaction of vermicompost fertilizer and EM4 had no significant effect on the growth and yield of soybean plants.



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## 1. INTRODUCTION

Domestic soybean production has only reached 920 thousand tons/year. The fulfillment of soybean needs of 67.99% must be imported from abroad, this is because domestic production is unable to meet the demand of tofu and tempeh producers. Low productivity is caused by agricultural land that has experienced degradation, especially related to the very low organic carbon content in the soil, which is 2%. Whereas to obtain optimal productivity, organic carbon is needed around 2.5% (Fanggidae *et al*., 2020).

There are many ways to meet the availability of nutrients in the soil. One of them is through fertilization. It is important to provide sufficient nutrition to plants through fertilization with the right dosage based on soil analysis (Nora and Novita, 2023). Fertilization can be applied directly to the soil, and can also be applied through the leaves. Plants will grow well and fertile if the required nutrients are available sufficiently and in balance and the formation of new shoots or leaves will be better with the availability of nutrients for plants (Tamba *et al*., 2017).

The use of organic fertilizers can be a solution to reduce the excessive use of inorganic fertilizers. This is a breakthrough in reducing the excessive use of inorganic fertilizers which have an impact on soil damage and loss of nutrients in the soil. Based on its form, organic fertilizers can be grouped into solid organic fertilizers and liquid organic fertilizers. Judging from the ingredients, organic fertilizers include manure, compost, vermicompost, peat, seaweed, and guano (Lokha, *et al*., 2021).

The use of vermicompost from used earthworm maintenance media along with worms or earthworm waste that can be used as fertilizer because it is an organic material that can improve the physical, chemical and biological properties of the soil, because in addition to containing nutrients that are ready to be absorbed by plants, it also contains growth regulating hormones such as auxin, so that the application of vermicompost to red ginger plants can increase growth and production. Vermicompost has a complete nutrient content and contains plant growth regulating hormones (Lidar, *et al*., 2021).

EM4 activator is an agricultural cultivation technology to improve the health and fertility of soil and plants. Microbes act as decomposers to accelerate the decay of organic matter and become antagonists for pathogens (Pratomo et al., 2023). EM4 contains lactobacillus, photosynthetic bacteria, yeast, actinomycetes, and decomposing fungi that can be used as inoculants to increase the diversity of soil microbes to ferment organic matter into simple organic compounds that are easily absorbed by plant roots, so that the quality and quantity of plant production increases (Asrijal, *et al*., 2018).

In the context of sustainable agriculture, the use of organic fertilizers such as vermicompost and biological activators such as EM4 is important as an environmentally friendly alternative to high dependence on inorganic fertilizers. The growing global crisis in chemical fertilizer supply and soil degradation due to excessive use of synthetic fertilizers demand biological-based solutions that can improve soil structure, increase microbial activity, and optimize natural plant nutrient uptake.

The combination of vermicompost, rich in macro and micro nutrients, and EM4, containing effective microorganisms such as Lactobacillus sp., Rhodopseudomonas sp., and Saccharomyces sp., is expected to synergistically enhance plant growth and productivity. This research is important to evaluate the effectiveness of this combination, particularly in the context of chemical fertilizer shortages and the need to increase national soybean production.

## 2. METHOD

### 2.1 Location and Time

The study was conducted on Jalan Sei Mencirim, Kutalimbaru Subdistrict, Deli Serdang Regency, North Sumatra, at an elevation of +30 meters above sea level. The study was conducted from June to September 2023.

### 2.2 Materials and Equipment

The materials used in this study included soybean seeds (Glycine max L.) of the Grobogan variety, 5 kg polybags measuring 40 x 20 cm, Decis 25 EC, casing fertilizer, and EM4. The tools used in the study included plastic rope, a measuring tape, a machete, plywood, label paper, a marker, nails, a shovel, a watering can, a measuring cup, a scale, writing utensils, and an observation notebook.

### 2.3 Research Method

The study was conducted using a factorial Randomized Block Design (RAK) with two factors studied, namely: The first factor is the provision of Vermicompost Fertilizer (K) with 4 levels, namely: K1 = 200 gr / plant; K2 = 300gr / plant; K3 = 400 gr / plant; K4 = 500 gr / plant. The second factor is the provision of EM4 (E) with 3 levels, consisting of: E0 = No treatment (control); E1 = Concentration 25 ml / liter of water; E2 = Concentration 50 ml / liter of water.

### 2.4 Research Implementation

#### 2.4.1 Land Preparation

The land is cleared using tools such as a brush cutter or machete, then cleared of grass on the surface of the soil. Land clearing aims to prevent competition between the main crop and weeds and to avoid disease.

#### 2.4.2 Soil Preparation

The land used for planting is first cleared of weeds and loosened to level it, and drainage ditches are made to prevent waterlogging in case of rain.

#### 2.4.3 Filling Polybags
Polybags are filled with prepared soil until full, which is used as the growing medium for soybean plants. The filled polybags are then neatly arranged on the cleared land.

#### 2.4.4 Application of Kascing Fertilizer
Kascing fertilizer is applied once before planting by mixing it into the soil as a base fertilizer. During soil preparation, the mixture is applied according to the recommended rate of Kascing fertilizer.

#### 2.4.5 EM4 Application
EM4 is applied once before planting by mixing the solution with 1 liter of water according to the treatment rate and then poured into the poly bags filled with soil. The bags are then incubated for 2 weeks, covered with a tarp.

#### 2.4.6 Planting
Before planting, select good seeds to reduce the percentage of germination failure. Next, make planting holes 2-3 cm deep using a trowel, and place 2 soybean seeds in each hole, then cover with soil. After planting, water sufficiently.

### 2.5 Observation Parameters
The parameters measured were plant height, number of leaves, stem diameter, number of productive branches per plant, number of pods per plant, weight of pods per plant.

### 2.6 Data Analysis
The research data were analyzed using Analysis of Variance (ANOVA) with Factorial Randomized Block Design (RAK). If the results are significantly different, it is continued with a mean difference test according to Duncan's Multiple Range Test (DMRT) at a 5% confidence level.

## 3. RESULTS AND DISCUSSION

### 3.1 Plant Height
Plant height after application of vermicompost and EM4 fertilizer at the ages of 2, 4, 6, 8 and 10 MST, along with its analysis of variance can be seen in Appendix 4-8. Based on the analysis of variance, vermicompost treatment at the ages of 2 to 10 MST had a significant effect on plant height parameters. However, EM4 treatment and the combination of both treatments had no significant effect. Data on average plant height can be seen in Table 1.

Based on Table 1, application of vermicompost had a significant effect on plant height at the ages of 2, 4, 6, 8 and 10 MST. The best results in the application of vermicompost were found in the K4 treatment with a dose of 500 g/plant with an average of 86.56 cm, significantly different from the K3 treatment with an average of 83.53 cm, K2 with an average of 79.69 cm and K1 which had the lowest plant height growth of 78.42 cm. This is thought to be because without being given vermicompost, the availability of nutrients is very low so that plant height growth with a small amount of vermicompost has the lowest plant height growth. Nutrients play a very important role in the vegetative growth process in plants, the nutrients N, P and K are macro nutrients that plants need in large quantities to support plant growth. The graph of the relationship between soybean plant height and vermicompost fertilizer treatment at the ages of 2, 4, 6, 8 and 10 MST is shown in (Figure 1).

**Table 1.** Plant Height with Vermicompost and EM4 Fertilizer Treatment at Ages 2, 4, 6, 8 and 10 MST

| Treatment | Plant Height | | | | |
|---|---|---|---|---|---|
| | 2 WAP | 4 WAP | 6 WAP | 8 WAP | 10 WAP |
| Vermicompost Fertilizer | | | ……..(cm)…….. | | |
| $K_1$ | 20,03 d | 37,19 d | 56,81 d | 68,72 d | 78,42 d |
| $K_2$ | 21,92 c | 41,42 c | 61,14 c | 69,89 c | 79,69 c |
| $K_3$ | 24,83 b | 45,61 b | 65,86 b | 73,72 b | 83,53 b |
| $K_4$ | 25,08 a | 47,58 a | 68,44 a | 76,61 a | 86,56 a |
| EM4 | | | | | |
| $E_0$ | 22,44 | 41,92 | 62,56 | 72 | 81,17 |
| $E_1$ | 22,98 | 44,13 | 64,79 | 73,71 | 83,54 |
| $E_2$ | 23,48 | 42,81 | 61,83 | 71 | 81,44 |
| Combination (KxE) | | | | | |
| $K_1E_0$ | 19,67 | 37,5 | 56,92 | 68,75 | 78,25 |
| $K_1E_1$ | 20,25 | 38 | 58,17 | 70 | 79,75 |
| $K_1E_2$ | 20,17 | 36,08 | 55,33 | 67,42 | 77,25 |
| $K_2E_0$ | 20,58 | 40,08 | 60,67 | 69,67 | 78,92 |
| $K_2E_1$ | 22 | 43,58 | 62,67 | 71,33 | 81,25 |
| $K_2E_2$ | 23,17 | 40,58 | 60,08 | 68,67 | 78,92 |
| $K_3E_0$ | 25 | 45,08 | 66,58 | 73,25 | 82,5 |
| $K_3E_1$ | 24,92 | 46,25 | 67,17 | 75 | 84,33 |

| | | | | | |
|---|---|---|---|---|---|
| $K_3E_2$ | 24,58 | 45,5 | 63,83 | 72,92 | 83,75 |
| $K_4E_0$ | 24,5 | 45 | 66,08 | 76,33 | 85 |
| $K_4E_1$ | 24,75 | 48,67 | 71,17 | 78,5 | 88,83 |
| $K_4E_2$ | 26 | 49,08 | 68,08 | 75 | 85,83 |

Description: Numbers followed by different letters in the same column are significantly different according to the 5% DMRT test.

EM4 treatment on soybean plants had no significant effect on measuring plant height. The highest data results w ere in treatment E1 with a mean of 83.54 cm and the lowest were in treatment E0 with a mean of 81.17 cm. Likewise, the combination of the two treatments had no significant effect, the highest data was in treatment K4E1 with a mean of 88.83 cm.

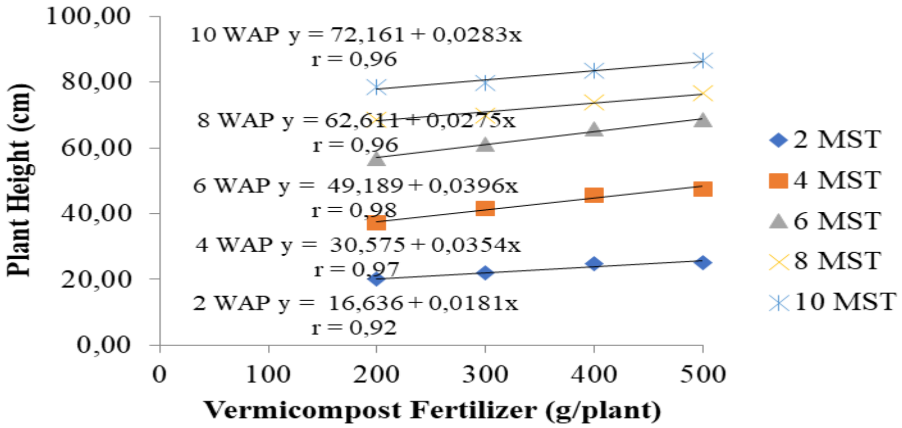


**Figure 1.** Graph of the Relationship between Soybean Plant Height and Vermicompost Fertilizer Treatment at Ages 2, 4, 6, 8 and 10 WAP

Based on Figure 1, the height of soybean plants at ages 2, 4, 6, 8 and 10 WAP with the provision of vermicompost fertilizer treatment formed a positive linear relationship with the equation age 2 WAP $\hat{y}$ = 16.636 + 0.0181x with r value = 0.92, age 4 WAP $\hat{y}$ = 30.575 + 0.0354x with r value = 0.87, age 6 WAP $\hat{y}$ = 49.189 + 0.0396x with r value = 0.98, age 8 WAP $\hat{y}$ = 62.611 + 0.0275x with r value = 0.96 and age 10 MST $\hat{y}$ = 72.161 + 0.0283x with r value = 0.96. Shows that as the dose increases by 0.02 g/plant, plant height growth will increase, K4 treatment with a dose of 500 g/plant with an average of 86.56 cm is the best treatment compared to K1, K2 and K3.

Based on the results of statistical analysis, it shows that the use of vermicompost showed significant results on plant height at the ages of 2, 4, 6, 8 and 10 MST. This is thought to be because the nutrients N, P, and K in vermicompost fertilizer are sufficient to meet plant needs. Macro nutrients such as N, P, and K are very important nutrients for plant growth, especially vegetative growth (Saragih et al., 2013) explained that with the addition of N fertilizer, plant height will increase. Amino acids, nucleic acids, and chlorophyll all contain nitrogen. Based on the statement (Wahyudin, 2019) vermicompost has a higher quality and is richer in nutrients than other organic fertilizers. 0.5-2.0% N, 0.06-0.68% P2O5, 0.10-0.68% K2O, and 0.50-3.50% Ca are all in vermicompost. Vermicompost is very good for plant growth because of its high nutrient content and the presence of auxin. Other hormones, humic acids, enzymes, and soil microorganisms that are good for soil fertility can also be found in vermicompost."

**3.2 Number of leaves (strands)**

The number of leaves after the application of vermicompost and EM4 fertilizers at the ages of 2, 4, 6, 8 and 10 MST, along with the analysis of variance can be seen in Appendix 9-13. Based on the analysis of variance, the vermicompost treatment at the ages of 2 to 10 MST had a significant effect on the number of leaves parameter. However, the EM4 treatment and the combination of the two treatments had no significant effect. The average number of leaves data can be seen in Table 2.

Based on Table 2, the application of vermicompost had a significant effect on the number of leaves at the ages of 2, 4, 6, 8 and 10 MST. The best results in the application of vermicompost fertilizer were in the K3 treatment with a dose of 400 g/plant with an average of 37.81 cm, which was not significantly different from the K4 treatment with an average of 37.53 leaves, K1 with an average of 35.47 leaves and K2 which had the lowest leaf growth of 34.06 leaves. This is thought to be because the growth of the number of leaves in soybean plants can grow well at the optimum dose. Nutrients play a very important role in the vegetative growth process in plants, the nutrients N, P and K are macro nutrients that plants need in large quantities to support plant growth. The graph of the relationship between the number of soybean leaves and vermicompost fertilizer treatment at the ages of 2, 4, 6, 8 and 10 MST is shown in (Figure 2).

EM4 treatment on soybean plants had no significant effect on measuring the number of leaves. The highest data results were in treatment E1 with an average of 36.83 strands and the lowest were in treatment E2 with an average of 35.67 cm. Likewise, the combination of the two treatments had no significant effect, the highest data was in treatment K3E2 with an average of 39.42 strands.

**Table 2.** Number of Leaves with Vermicompost and EM4 Fertilizer Treatment at Ages 2, 4, 6, 8, and 10 WAP

| Treatment | Number of Leaves | | | | |
|---|---|---|---|---|---|
| | 2 WAP | 4 WAP | 6 WAP | 8 WAP | 10 WAP |
| Vermicompost Fertilizer | | | | | |
| | | | ……..(strands)…….. | | |
| $K_1$ | 3,33 b | 7,42 b | 16,36 b | 26,17 d | 35,47 b |
| $K_2$ | 3,39 ab | 7,92 ab | 17,75 c | 25,83 c | 34,06 c |
| $K_3$ | 3,83 ab | 8,89 ab | 20,19 ab | 29,28 ab | 37,81 a |
| $K_4$ | 3,86 a | 8,75 a | 20,50 a | 29,86 a | 37,53 ab |
| EM4 | | | | | |
| $E_0$ | 3,56 | 8,06 | 18,96 | 27,73 | 36,15 |
| $E_1$ | 3,67 | 8,65 | 19,71 | 28,44 | 36,83 |
| $E_2$ | 3,58 | 8,02 | 17,44 | 27,19 | 35,67 |
| Combination (KxE) | | | | | |
| $K_1E_0$ | 3,42 | 7,58 | 16,67 | 25,33 | 34,75 |
| $K_1E_1$ | 3,42 | 7,42 | 17,92 | 27,42 | 36,50 |
| $K_1E_2$ | 3,17 | 7,25 | 14,50 | 25,75 | 35,17 |
| $K_2E_0$ | 3,25 | 7,50 | 17,25 | 25,17 | 33,67 |
| $K_2E_1$ | 3,42 | 8,67 | 19,58 | 26,92 | 35,42 |
| $K_2E_2$ | 3,50 | 7,58 | 16,42 | 25,42 | 33,08 |
| $K_3E_0$ | 3,75 | 8,50 | 20,33 | 28,92 | 37,67 |
| $K_3E_1$ | 3,92 | 9,33 | 20,67 | 27,67 | 36,33 |
| $K_3E_2$ | 3,83 | 8,83 | 19,58 | 31,25 | 39,42 |
| $K_4E_0$ | 3,83 | 8,67 | 21,58 | 31,50 | 38,50 |
| $K_4E_1$ | 3,92 | 9,17 | 20,67 | 31,75 | 39,08 |
| $K_4E_2$ | 3,83 | 8,42 | 19,25 | 26,33 | 35,00 |

Description: Numbers followed by different letters in the same column are significantly different according to the 5% DMRT test.

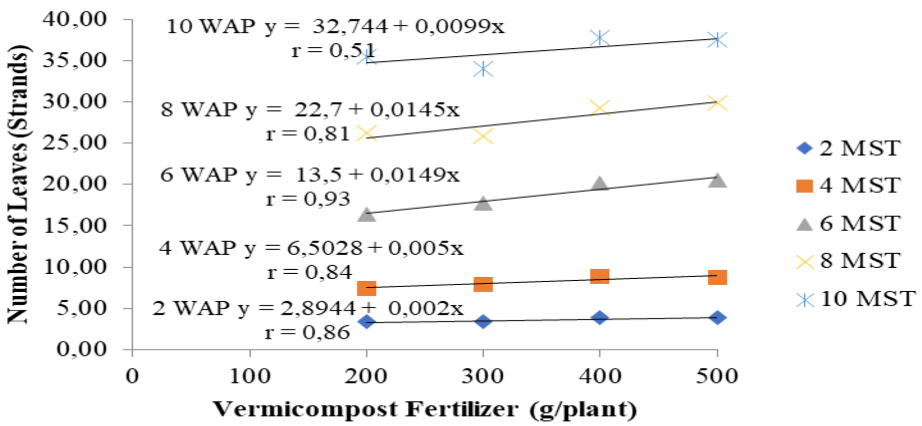


**Figure 2.** Graph of the Relationship between the Number of Soybean Plant Leaves and Vermicompost Fertilizer Treatment at Ages 2, 4, 6, 8 and 10 MST

Based on Figure 2, the number of soybean plant leaves at the ages of 2, 4, 6, 8 and 10 MST with the provision of vermicompost fertilizer treatment forms a positive linear relationship with the equation of age 2 MST $\hat{y} = 2.8944 + 0.002x$ with r value = 0.86, age 4 MST $\hat{y} = 6.5028 + 0.005x$ with r value = 0.84, age 6 MST $\hat{y} = 13.5 + 0.0149x$ with r value = 0.93, age 8 MST $\hat{y} = 22.7 + 0.0145x$ with r value = 0.96 and age 10 MST $\hat{y} = 32.744 + 0.0099x$ with r value = 0.51. Shows that as the dose increases by 0.009 g/plant, the growth of the number of leaves will increase, the K3 treatment with a dose of 400 g/plant with an average of 37.81 leaves is the best treatment.

Based on the results of statistical analysis, it shows that the use of vermicompost showed significant results on the number of leaves at the ages of 2, 4, 6, 8 and 10 MST. This is thought to be because the nutrients N, P, and K in vermicompost fertilizer are sufficient to meet plant needs.

This is because vermicompost given in larger doses can increase the growth of the number of leaves in soybean plants. This may be due to the fact that plants can utilize the macro and micro nutrients contained in vermicompost optimally. This is in accordance with the statement (Sukasih, 2017) which states that soybean plants will produce more leaves as soon as sufficient nutrients are added to meet plant needs. Vermicompost application is a catalyst for plant growth in terms of leaf production. This is because vermicompost contains macro and micro nutrients needed by plants. In addition, vermicompost can improve soil texture, structure, porosity, and aeration.

Saroh, (2020) added that the growth of the number of leaves in soybean plants increased, along with the increasing dose of vermicompost applied to the plants. In addition, the environment is an important factor in the formation of the number of leaves. Light, temperature, and climate are environmental elements that influence. Light intensity, light quality, and photoperiod are three aspects of light that affect plant growth and development. According to the statement of Assiddiqi et al., (2022) due to limited light capture, too little light intensity can affect how many leaves the plant produces, which in turn affects the rate of photosynthesis.

### 3.3 Stem Diameter (mm)

Stem diameter after application of vermicompost and EM4 fertilizer at the ages of 2, 4, 6, 8 and 10 MST, along with its analysis of variance can be seen in Appendix 14-18. Based on the analysis of variance, vermicompost treatment at the ages of 2 to 10 MST had a significant effect on the stem diameter parameter. However, EM4 treatment and the combination of both treatments had no significant effect. The average stem diameter data can be seen in Table 3.

**Table 3.** Stem Diameter with Vermicompost and EM4 Fertilizer Treatment at Ages 2, 4, 6, 8 and 10 WAP

| Treatment | Stem Diameter | | | | |
|---|---|---|---|---|---|
| | 2 WAP | 4 WAP | 6 WAP | 8 WAP | 10 WAP |
| Vermicompost Fertilizer | | | | | |
| | | | ……..(mm)…….. | | |
| $K_1$ | 0,22 b | 0,34 b | 0,56 b | 0,69 b | 0,79 b |
| $K_2$ | 0,23 ab | 0,37 ab | 0,60 ab | 0,72 ab | 0,82 ab |
| $K_3$ | 0,24 a | 0,41 ab | 0,66 ab | 0,76 ab | 0,88 ab |
| $K_4$ | 0,24 a | 0,44 a | 0,70 a | 0,79 a | 0,91 a |
| EM4 | | | | | |
| $E_0$ | 0,24 | 0,38 | 0,62 | 0,74 | 0,85 |
| $E_1$ | 0,23 | 0,40 | 0,66 | 0,77 | 0,88 |
| $E_2$ | 0,24 | 0,38 | 0,61 | 0,72 | 0,83 |
| Combination (KxE) | | | | | |
| $K_1E_0$ | 0,23 | 0,35 | 0,57 | 0,70 | 0,80 |
| $K_1E_1$ | 0,22 | 0,34 | 0,59 | 0,74 | 0,85 |
| $K_1E_2$ | 0,22 | 0,33 | 0,53 | 0,63 | 0,73 |
| $K_2E_0$ | 0,25 | 0,37 | 0,57 | 0,68 | 0,77 |
| $K_2E_1$ | 0,23 | 0,39 | 0,63 | 0,78 | 0,86 |
| $K_2E_2$ | 0,23 | 0,36 | 0,58 | 0,72 | 0,83 |
| $K_3E_0$ | 0,25 | 0,41 | 0,67 | 0,77 | 0,89 |
| $K_3E_1$ | 0,24 | 0,42 | 0,66 | 0,77 | 0,90 |
| $K_3E_2$ | 0,23 | 0,40 | 0,65 | 0,76 | 0,86 |
| $K_4E_0$ | 0,22 | 0,40 | 0,66 | 0,81 | 0,94 |
| $K_4E_1$ | 0,25 | 0,46 | 0,74 | 0,80 | 0,90 |
| $K_4E_2$ | 0,26 | 0,45 | 0,69 | 0,77 | 0,89 |

Description: Numbers followed by different letters in the same column are significantly different according to the 5% DMRT test.

Based on Table 3, application of vermicompost had a significant effect on stem diameter at the ages of 2, 4, 6, 8 and 10 MST. The best results in the application of vermicompost fertilizer were found in the K4 treatment with a dose of 500 g/plant with an average of 0.91 cm, which was not significantly different from the K3 treatment with an average of 0.88 cm, K2 with an average of 0.82 cm and K1 which had the lowest stem diameter growth of 0.79. This is thought to be because the growth of stem diameter in soybean plants can grow well at the optimum dose. Nutrients play a very important role in the vegetative growth process in plants, the nutrients N, P and K are macro nutrients that plants need in large quantities to support plant growth. The graph of the relationship between the diameter of the soybean plant stem and the treatment of vermicompost fertilizer at the ages of 2, 4, 6, 8 and 10 MST is shown in (Figure 3).

EM4 treatment on soybean plants had no significant effect on stem diameter measurements. The highest data results were found in treatment E1 with an average of 0.88 cm and the lowest were found in treatment E2 with an average of 0.83 cm. Likewise, the combination of both treatments had no significant effect. The highest data was found in treatment K4E0 with an average of 0.94 and the lowest was found in treatment K1E2 with an average of 0.73 cm.

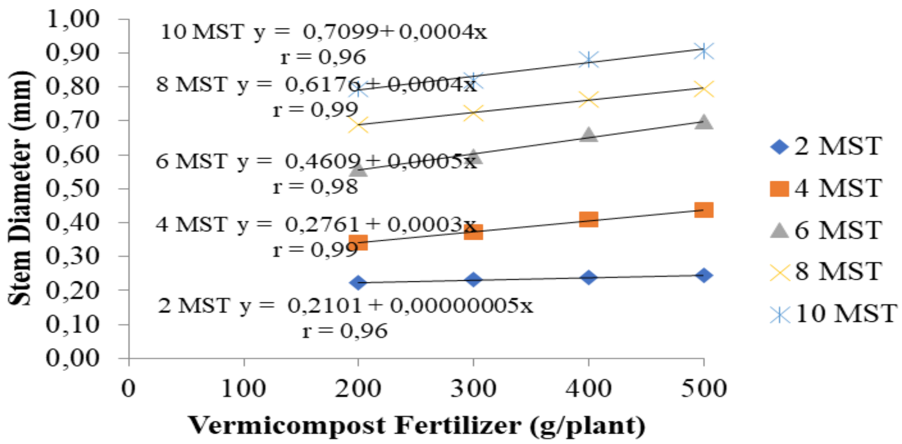


**Figure 3.** Graph of the Relationship between Soybean Plant Stem Diameter and Vermicompost Fertilizer Treatment at Ages 2, 4, 6, 8 and 10 MST

Based on Figure 3, the stem diameter of soybean plants aged 2, 4, 6, 8 and 10 MST with the provision of vermicompost fertilizer treatment forms a positive linear relationship with the equation age 2 MST $\hat{y} = 0.2101 + 0.00000005x$ with a value of r = 0.96, age 4 MST $\hat{y} = 0.2761 + 0.0003x$ with a value of r = 0.99, age 6 MST $\hat{y} = 0.4609 + 0.0005x$ with a value of r = 0.98, age 8 MST $\hat{y} = 0.6176 + 0.0004x$ with a value of r = 0.96 and age 10 MST $\hat{y} = 0.7099 + 0.0004x$ with a value of r = 0.96. Showing that as the dose increases by 0.0004 g/plant, the growth of stem diameter will increase," K4 treatment with a dose of 500 g/plant with an average of 0.91 cm is the best treatment.

Based on the results of statistical analysis, it shows that the use of vermicompost showed significant results on stem diameter at the ages of 2, 4, 6, 8 and 10 MST. Soybean plant stems have a larger diameter because of sufficient nutrition. In addition, the presence of N, P, and K nutrients in the soil in the amount needed by plants affects the reason why soybean plants have a larger stem diameter. This is in accordance with the statement of Sinda et al., (2015) which states that through the N and P elements it contains, vermicompost can increase plant vegetative growth, namely the growth of leaves, stems, and roots. The N element is also able to play a role in the development of green leaf color, thus becoming a good environment for soybean plant growth. This green leaf color helps plants carry out the process of photosynthesis, which leads to carbohydrate production. To maintain metabolic function, the carbohydrates produced will be distributed throughout the plant, with the remaining amount stored as plant products. To improve plant quality, the P element can also play a role in root growth.

### 3.4 Number of Productive Branches (branches)

The number of productive branches after the administration of vermicompost and EM4 fertilizers at the age of 10 MST, along with the analysis of variance can be seen in Appendix 19. Based on the analysis of variance, the vermicompost treatment at the age of 10 MST had a significant effect on the parameter of the number of productive branches. However, the EM4 treatment and the combination of the two treatments had no significant effect. The average data on the number of productive branches can be seen in Table 4.

**Table 4.** Number of Productive Branches with Vermicompost and EM4 Fertilizer Treatment at 10 WAP

| Treatment | Vermicompost | | | | Average |
|---|---|---|---|---|---|
| EM4 | $K_1$ | $K_2$ | $K_3$ | $K_4$ | |
| | | …………………(cabang)………………… | | | |
| $E_0$ | 6,50 | 6,58 | 7,17 | 7,00 | 6,81 |
| $E_1$ | 6,67 | 6,92 | 7,33 | 7,17 | 7,02 |
| $E_2$ | 6,75 | 6,58 | 6,92 | 7,33 | 6,90 |
| Average | 6,64 b | 6,69 ab | 7,14 ab | 7,17 a | |

Description: Numbers followed by different letters in the same column are significantly different according to the 5% DMRT test.

Based on Table 4, the provision of vermicompost fertilizer significantly affected the number of productive branches at the age of 10 MST. The best results in the provision of vermicompost fertilizer were found in the K4 treatment with a dose of 500 g/plant with an average of 7.17 branches, not significantly different from the K3 treatment with an average of 7.14 branches, K2 with an average of 6.69 branches and K1 which had the lowest growth in the number of productive branches of 6.64 branches. This is thought to be because the growth of the number of productive branches in soybean plants can grow well at the optimum dose. Nutrients play a very important role in the vegetative growth process in plants, the nutrients N, P and K are macro nutrients that plants need in large quantities to support plant growth. The graph of the relationship between the number of productive branches of soybean plants and vermicompost fertilizer treatment at the age of 12 MST is shown in (Figure 4).

EM4 treatment in soybean plants had no significant effect on the measurement of the number of productive branches. The highest data results were in treatment E1 with a mean of 7.02 branches and the lowest were in treatment E0 with a mean of 6.81 branches. Likewise, the combination of the two treatments had no significant effect, the highest data was in treatment K4E2 with a mean of 7.33 branches.

Based on Figure 4, the number of productive branches of soybean plants aged 10 MST with the provision of vermicompost fertilizer treatment forms a positive linear relationship with the equation of age 10 MST $\hat{y} = 6.1946 + 0.002x$ with a value of r = 0.86. Showing that as the dose increases by 0.002 g/plant, the growth of the number of productive branches will increase, the K4 treatment with a dose of 500 g/plant with an average of 7.17 branches is the best treatment.

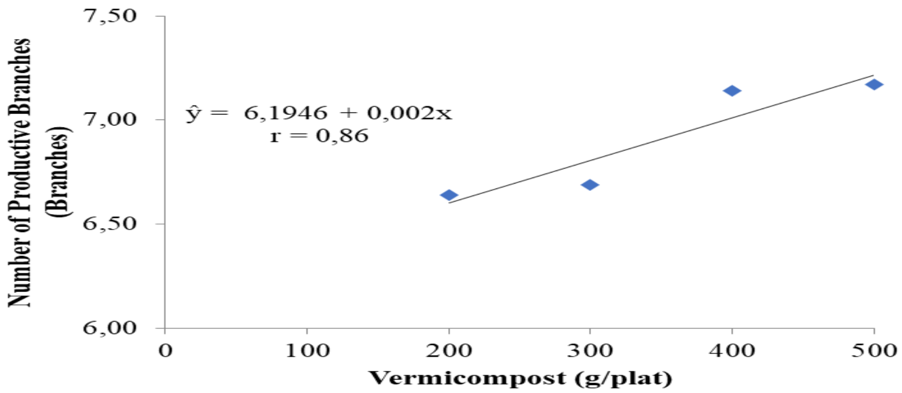


**Figure 4.** Graph of the Relationship between the Number of Productive Branches of Soybean Plants and Vermicompost Fertilizer Treatment at 10 WAP

Based on the results of statistical analysis, it shows that the use of vermicompost showed significant results on the number of productive branches at the age of 10 MST. The content of N nutrients in vermicompost causes the number of productive branches to increase. This is in accordance with the statement of Dosem et al., (2018) that vermicompost contains various nutrients needed by plants, including N, P, K, Ca, Mg, S, Fe, Mn, Al, Na, Cu, Zn, Bo, and Mo. For bacterial soil, vermicompost provides a source of nutrients. These nutrients will help microorganisms that decompose organic matter to continue to grow and reproduce faster. Nutrients in the media will increase with a larger dose of vermicompost so that plant needs are met.

### 3.5 Number of Pods per Plant (pods)

The number of pods per plant after the application of vermicompost and EM4 fertilizers at the age of 12 MST, along with the analysis of variance can be seen in Appendix 20. Based on the analysis of variance, the vermicompost treatment at the age of 12 MST had a significant effect on the parameter of the number of pods per plant. However, the EM4 treatment and the combination of the two treatments did not have a significant effect. Data on the average number of pods per plant can be seen in Table 5.

**Table 5.** Number of Pods per Plant with Vermicompost and EM4 Fertilizer Treatment at 12 MST

| Treatment EM4 | Vermicompost | | | | Average |
|---|---|---|---|---|---|
| | $K_1$ | $K_2$ | $K_3$ | $K_4$ | |
| | …………………(pods)……………………… | | | | |
| $E_0$ | 59,33 | 68,08 | 84,25 | 82,58 | 73,56 |
| $E_1$ | 78,83 | 86,75 | 91,67 | 95,22 | 88,12 |
| E2 | 77,17 | 64,50 | 61,75 | 102,11 | 76,38 |
| Average | 71,78 c | 73,11 bc | 79,22 b | 93,30 a | |

Description: Numbers followed by different letters in the same column are significantly different according to the 5% DMRT test.

Based on Table 5, the provision of vermicompost fertilizer significantly affected the number of pods per plant at the age of 12 MST. The best results in the provision of vermicompost fertilizer were in the K4 treatment with a dose of 500 g/plant with an average of 93.30 pods, significantly different from the K3 treatment with an average of 79.22 pods, but not significantly different from the K2 treatment with an average of 73.11 pods and K1 which had the lowest growth in the number of pods per plant of 71.78 pods. This is thought to be because the growth in the number of pods per plant in soybean plants can grow well at the optimum dose. Nutrients play a very important role in the vegetative growth process in plants, the nutrients N, P and K are macro nutrients that plants need in large quantities to support plant growth. The graph of the relationship between the number of pods per plant in soybean plants and vermicompost fertilizer treatment at the age of 12 MST is shown in (Figure 5).

EM4 treatment on soybean plants had no significant effect on measuring the number of pods per plant. The highest data results were in treatment E1 with a mean of 88.12 pods and the lowest were in treatment E0 with a mean of 73.56 pods. Likewise, the combination of the two treatments had no significant effect, the highest data was in treatment K4E1 with a mean of 102.11 pods and the lowest was in treatment K1E0 with a mean of 59.33 pods.

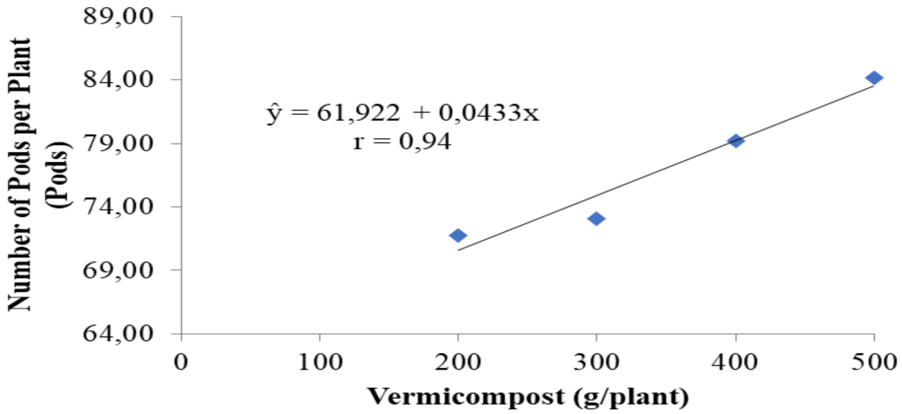


**Figure 5.** Graph of the Relationship between the Number of Pods per Plant in Soybean Plants and Vermicompost Fertilizer Treatment at 12 WAP

Based on Figure 5, the number of pods per soybean plant at 12 WAP with vermicompost fertilizer treatment forms a positive linear relationship with the equation at 12 WAP ŷ = 61.922 + 0.0433x with an r value of 0.94. Showing that as the dose increases by 0.0433 g/plant, the growth in the number of pods per plant will increase, the K3 treatment with a dose of 500 g/plant with an average of 93.30 pods is the best treatment. Based on the results of statistical analysis, it shows that the use of vermicompost shows significant results on the number of pods per plant at 12 WAP. The K element functions to increase root growth which affects the absorption of water into the plant properly so that it can provide maximum production results. This is in accordance with the statement of Gaol et al., (2014) that the plant's need for potassium is quite high and its influence is quite large on plant growth. Then the role of potassium is also to increase root growth which is needed in the formation of starch. Pangesti et al., (2017) added that soybean plants are usually planted on dry land, but it does not mean that soybean plants do not need water for growth and production, because water is the most compound needed in every plant growth. This is because water has an important role as a solvent and transports nutrients from within or given to the soil to enter the plant tissue.

### 3.6 Pod Weight per Plant (g)

The weight of pods per plant after the application of vermicompost and EM4 fertilizers at the age of 12 WAP, along with the analysis of variance can be seen in Appendix 21. Based on the analysis of variance, the vermicompost treatment at the age of 12 WAP had a significant effect on the parameter of pod weight per plant. However, the EM4 treatment and the combination of the two treatments had no significant effect. The average data of pod weight per plant can be seen in Table 6.

**Table 6.** Weight of Pods per Plant with Vermicompost and EM4 Fertilizer Treatment at 12 WAP

| Treatment | Vermicompost | | | | Average |
|---|---|---|---|---|---|
| EM4 | $K_1$ | $K_2$ | $K_3$ | $K_4$ | |
| | | …………………(g)…………………… | | | |
| $E_0$ | 89,85 | 71,16 | 113,45 | 97,61 | 93,02 |
| $E_1$ | 88,78 | 93,78 | 106,53 | 120,77 | 102,46 |
| $E_2$ | 72,62 | 92,44 | 102,87 | 122,83 | 97,69 |
| Average | 83,75 d | 85,79 c | 107,62 b | 113,74 a | |

Description: Numbers followed by different letters in the same column are significantly different according to the 5% DMRT test.

Based on Table 6, the provision of vermicompost fertilizer significantly affected the weight of pods per plant at the age of 12 MST. The best results in the provision of vermicompost fertilizer were in the K4 treatment with a dose of 500 g/plant with an average of 113.74 g significantly different from the K3 treatment with an average of 107.62 g, K2 with an average of 85.79 g and K1 which had the lowest growth in pod weight per plant 83.75 g. This is thought to be because the growth of pod weight per plant in soybean plants can grow well at the optimum dose. Nutrients play a very important role in the vegetative growth process in plants, the nutrients N, P and K are macro nutrients that plants need in large quantities to support plant growth. The graph of the relationship between pod weight per plant in soybean plants and vermicompost fertilizer treatment at the age of 12 MST is shown in (Figure 6). EM4 treatment in soybean plants had no significant effect on the measurement of pod weight per plant. The highest data results were in treatment E1 with a mean of 102.46 g and the lowest were in treatment E0 with a mean of 93.02 g. Likewise, the combination of the two treatments had no significant effect, the highest data was in treatment K4E2 with a mean of 122.83 g and the lowest was in treatment K2E0 with a mean of 71.16 g.

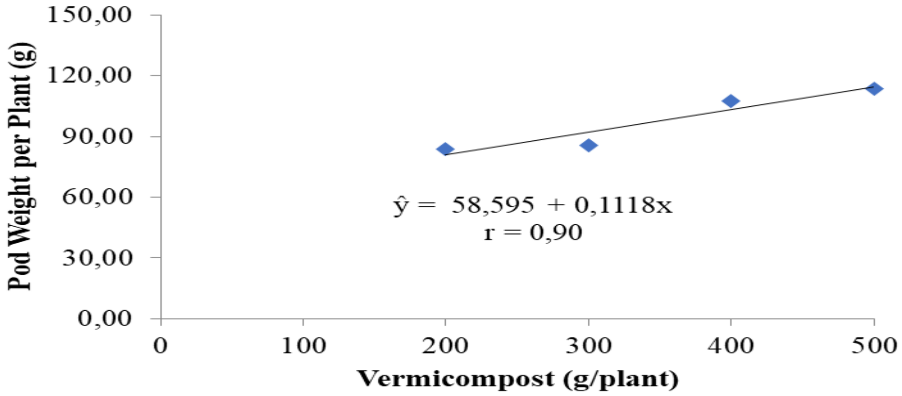


**Figure 6.** Graph of the Relationship between Pod Weight per Plant in Soybean Plants and Vermicompost Fertilizer Treatment at 12 WAP

Based on Figure 6, the weight of pods per soybean plant at 12 WAP with vermicompost fertilizer treatment forms a positive linear relationship with the equation at 12 WAP $\hat{y} = 58.595 + 0.1118x$ with an r value of 0.90. Showing that as the dose increases by 0.1118 g/plant, the growth of pod weight per plant will increase, K4 treatment with a dose of 500 g/plant with an average of 113.74 g is the best treatment. Based on the results of statistical analysis, it shows that the use of vermicompost shows significant results on the weight of pods per plant at 12 WAP. The provision of vermicompost has sufficient nutrient availability so that it can help maintain the balance of nitrogen (N) in the soil, especially in plant growth areas such as leaves, where plants produce starch, increasing starch synthesis can increase the weight of plant pods. This is in accordance with the statement of Suyudi et al., (2012) that potassium functions to maintain the balance of nitrogen and phosphorus. Starch synthesis and the movement of products from the photosynthesis process, including sugar, depend on potassium. However, starch production in plants occurs in the leaves, where the N element also contributes to plant growth. The weight of plant seeds can increase when high-starch foods are formed. Because the weight of the pods per plant is greater, the amount of carbohydrates stored in the stem also increases. As a result, as the number of leaves increases, high starch levels will also occur, which can increase the weight of plant seeds (Ramadhani, 2020). Then According to (Tadesse, 2013) added that the increased photosynthesis process will affect the amount of assimilates produced which will ultimately have an impact on increasing the amount, volume and weight produced.

## 4. CONCLUSION

The provision of vermicompost fertilizer significantly affected the parameters of plant height, number of leaves, stem diameter, number of productive branches, number of pods, and pod weight in soybean plants. The provision of EM4 did not significantly affect all parameters observed in soybean plants. The interaction of vermicompost and EM4 did not significantly affect all parameters observed in soybean plants. This study indicates that vermicompost application alone significantly improves the growth and yield of soybean. For farmers, using 500 g/plant vermicompost is recommended to boost production sustainably without chemical fertilizers. Since EM4 did not show significant results in this setup, future studies should explore its repeated application during vegetative and reproductive stages. Further research is also needed across diverse soil types and field conditions to validate the findings.

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