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Application of Goat Manure Organic Fertilizer Dosages and EM-4 Concentrations on the Growth and Yield of Eggplant (Solanum Melongena L.)

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ABSTRACT: This study aimed to determine the effect of goat manure bokashi fertilizer and EM-4 concentration on the growth and yield of eggplant (Solanum melongena L.). The experiment was conducted in Bagi Village, Madiun District, Madiun Regency from March to May 2025 using a factorial Randomized Block Design with two factors: bokashi doses (6, 8, and 10 kg/plot) and EM-4 concentrations (10, 20, and 30 ml/l) with three replications. The results showed a significant interaction between the two factors, with the best combination obtained at 10 kg/plot bokashi + 20 ml/l EM-4 (B3E2), which produced the highest number of fruits, fruit diameter, fruit weight, and number of flowers. Individually, 10 kg/plot bokashi resulted in the best vegetative growth, while EM-4 concentrations of 20–30 ml/l improved leaf area, number of fruits, fruit diameter, and fruit weight. The results of the study showed an interaction between the dose of goat manure bokashi fertilizer and the concentration of EM4 on eggplant plant yields, especially on the number of fruits, fruit diameter, and fruit weight per plant. The optimal treatment combination was the provision of 10 kg/plot of goat manure bokashi with 20 ml/l of EM4 (B3E2).

KEYWORDS: Eggplant, goat manure bokashi fertilizer, EM-4, growth, yield.

1. INTRODUCTION

As an agricultural country rich in history, Indonesia has many agricultural commodities that are popular among tourists, one of which is eggplant. Eggplant is one of the vegetable commodities favored by the Indonesian people and is considered one of the most popular vegetable commodities. According to (Fitrianti et al., 2018), eggplant contains quite high nutrients, especially vitamin A and phosphorus. Gelatik eggplant (Solanum melongena L.) has the potential as a nutritious vegetable with a very high water content and low energy (Budi et al., 2022). In 100 grams of fresh weight, eggplant has a water content of around 91.3 g and energy of 32.6 kcal, while the carbohydrate content is around 3.0 g, protein 0.86 g, and fat 0.05 g(De Melo et al., 2018). In addition, the skin of gelatik eggplant is known to be rich in flavonoids of around 0.202% which indicates the potential for higher antioxidant activity. This indicates that eggplant plants have considerable potential to be used as a source of nutritious vegetables for the wider community.

Improving soil fertility through fertilizer application is one strategy to increase eggplant yields. Fertilization is necessary to supplement plant nutrition to achieve desired production targets. One way to increase plant productivity is through the use of organic fertilizers. According to (Ramadhan et al., 2024;Mardiyah, et al, 2021), organic fertilizers are produced when microorganisms decompose organic matter, producing nutrients necessary for growth and development. The importance of organic fertilizers in business operations is to maintain physical, chemical, and biological health, ultimately increasing fertilizer efficiency and longevity. For example, goat manure can be considered a type of nutrient-rich organic fertilizer.

One type of organic material that can increase the amount of nutrients available to plants is goat manure. This plant has a nitrogen indicator that can influence the growth of plant parts related to photosynthesis, such as leaves. Furthermore, the application of goat manure has an impact on the physical and chemical conditions of the soil and suppresses microorganisms in the soil (Budi, 2007). However, goat manure remains stable and takes a long time to decompose in the soil, which can inhibit plant growth as optimally as possible (Fitrianti et al., 2018)(Budi L.S, Rahayu, S, dan Nurwantara, 2018) Therefore, a combination of organic fertilizers such as goat manure is recommended to maintain plant nutrient balance.

One strategy to increase eggplant production is the use of organic fertilizers in the nutrient system. One example of an organism that can be used effectively for eggplant is goat manure. This is because goat manure contains relatively higher levels of potassium than other fertilizers and can improve the physical, chemical, and biological properties of the soil (Yuanita et al., 2016).

Eggplant growth and yield can be further enhanced through microbial inoculation into the soil. Introducing microorganisms such as Effective Microorganism 4 (EM4) into the environment can improve eggplant growth and yield. (Pratiwi & Maghfoer, 2019)

explains that Effective Microorganism 4 (EM4) is a mixed culture of various microorganisms that are beneficial for plant growth. EM4 contains Lactobacillus sp and a small number of photosynthetic bacteria, Streptomycetes sp. The application of EM-4 to the soil can improve soil fertility and soil properties (Supriyanto, 2020).

2. METHOD

This research was conducted in Bagi Village, Madiun District, Madiun Regency, East Java, at an altitude of 76 m above sea level with a temperature of 22–32°C and a tropical climate, from March–May 2025. The materials used were eggplant seeds, goat manure bokashi fertilizer, and Effective Microorganism 4 (EM4). The tools used included hoes, knives, scissors, trays, stakes, treatment boards, identification boards, rulers, stationery, tarpaulins, and harvesting tools. The study used a factorial Randomized Block Design (RBD) with two factors: goat manure bokashi dosage (6 kg/plot, 8 kg/plot, and 10 kg/plot) and EM4 concentration (10 ml/l, 20 ml/l, and 30 ml/l). This resulted in nine treatment combinations with three replications and a total of 27 plots, each containing five plants, with three plant samples per plot.

Observations included growth parameters (plant height, stem diameter, number of leaves, and leaf area) and crop yields (number of flowers, number of fruits, fruit diameter, fruit weight, and fruit dry weight). Data were analyzed using ANOVA at the 5% level and if there was a significant effect, it was continued with Duncan's Multiple Range Test (DMRT) at the 5% level.

3. RESULT AND DISCUSSION

3.1. Table

Table 1. Average Plant Height in Treatment of Goat Manure Bokashi Fertilizer Dosage and Effective Microorganism 4 (EM4) Concentration at Various Ages.

TREATMENT	PLANT HEIGHT (CM)		
	14HST	28HST	42HST
GROWING MEDIA			
B/6KG	8.18a	15.00a	27.96a
B/8KG	12.58b	26.48b	40.39b
B/10KG	12.74b	25.63b	42.08b
EM4			
10 ML/L	9.89a	18.15a	32.97a
30 ML/L	11.73b	23.70b	38.73b
20 ML/L	11.88b	25.25b	38.74b

Note: Numbers followed by different letters in the same column indicate significant differences in the 5% Duncan test.

Table 1. Based on observations of plant height at 14 days after planting (DAP), 28 days after planting (DAP), and 42 days after planting, the combination of 10 kg of goat manure bokashi fertilizer with 20 ml/L of effective microorganism 4 (EM4) produced the highest plant heights, with an average of 42.08 cm at 42 days after planting. Conversely, the combination of the lowest dose of 6 kg of goat manure bokashi with 10 ml/L of effective microorganism 4 (EM4) produced the lowest results, with an average of 32.97 cm.

Table 2. Average Plant Stem Diameter in Goat Manure Bokashi Fertilizer Doses and Effective Microorganism 4 (EM4) Concentrations at Various Ages.

TREATMENT	PLANT STEM DIAMETER (MM)		
	14HST	28HST	42HST
GROWING MEDIA			
B/6KG	0.90a	1.17a	1.74a
B/8KG	1.19b	1.34b	1.92b
B/10KG	1.20b	1.37b	1.92b
EM4			
10 ML/L	1.00a	1.22a	1.77a
20 ML/L	1.11ab	1.33b	1.90b
30 ML/L	1.18b	1.33b	1.90b

Note: Numbers followed by different letters in the same column indicate a significant difference in the 5% Duncan test.

Table 2. Based on observations of plant stem diameter at 14 days after planting (DAP), 28 days after planting (DAP), and 42 days after planting, the combination of 10 kg of goat manure bokashi fertilizer with 20-30 ml/L of effective microorganism 4 (EM4) resulted in the highest stem diameter, with an average of 1.92 cm at 42 days after planting. Conversely, the combination of 6 kg of goat manure bokashi with 10 ml/L of effective microorganism 4 (EM4) resulted in an average of 1.77 cm.

Table 3. Average Number of Leaves per Plant in Treatment of Goat Manure Bokashi Fertilizer Dosage and Effective Microorganism 4 (EM4) Concentration at Various Ages.

TREATMENT	NUMBER OF LEAVES PER PLANT (SHADE)		
	14HST	28HST	42HST
GROWING MEDIA			
B/6KG	3.85a	5.48a	11.11a
B/8KG	5.33b	8.07b	13.55b
B/10KG	5.52b	7.85b	13.33b
EM4			
10 ML/L	4.29a	7.00a	12.33a
30 ML/L	5.14b	7.33a	12.70a
20 ML/L	5.26b	7.07a	12.96a

Note: Numbers followed by different letters in the same column indicate a significant difference in the 5% Duncan test.

Table 3. Based on observations of the number of leaves per plant at 14 DAP, 28 DAP, and 42 DAP, the combination of 8-10 kg of goat manure bokashi fertilizer with 20-30 ml/L of effective microorganism 4 (EM4) produced the highest number of leaves, approximately 13.55 leaves, at 42 DAP. In contrast, the lowest combination of 6 kg of goat manure bokashi with 10 ml/L of effective microorganism 4 (EM4) only produced approximately 12.33 leaves.

Table 4. Average Leaf Area of Plants in Different Treatments of Goat Manure Bokashi Fertilizer Doses and Effective Microorganism 4 (EM4) Concentrations at Various Ages.

TREATMENT	PLANT LEAF AREA (CM)		
	14HST	28HST	42HST
GROWING MEDIA			
B/6KG	12.66a	83.89a	1738.95a
B/10KG	25.58b	126.31b	1843.44a
B/8KG	30.29b	121.81b	1890.83a
EM4			
10 ML/L	15.09a	82.73a	1219.18a
30 ML/L	26.75b	118.57b	1938.71b
20 ML/L	26.69b	130.71b	2315.33b

Note: Numbers followed by different letters in the same column indicate a significant difference in the 5% Duncan test.

Table 4. Based on observations of plant leaf area at 14, 28, and 42 days after planting, observations at 42 days after planting indicate that the 20 ml/L effective microorganism 4 (EM4) treatment produced the largest leaf area, approximately 1890.83 cm2. Meanwhile, the 10 ml/L effective microorganism 4 (EM4) treatment produced the lowest yield, at 1219.18 cm2. Bokashi doses of 8 and 10 kg also showed large leaf areas, but the differences between the two were not significant.

Table 5. Average Number of Flowers per Plant in Goat Manure Bokashi Fertilizer Doses and Effective Microorganism 4 (EM4) Concentrations at Various Ages.

TREATMENT	NUMBER OF FLOWERS PER PLANT				
	42HST	56HST	63HST	70HST	77HST
GROWING MEDIA					
B/6KG	13.55a	4.66a	10.77a	13.66a	16.66a
B/8KG	15.03b	6.33b	12.33b	15.03b	18.33b
B/10KG	15.22b	6.44b	12.44b	15.22b	18.22b
EM4					
10 ML/L	14.00a	5.11a	11.11a	14.11a	17.11a
30 ML/L	14.59ab	6.11b	12.22b	14.59a	17.89ab
20 ML/L	15.22b	6.22b	12.22b	15.22a	18.22b

Note: Numbers followed by different letters in the same column indicate a significant difference in the Duncan 5% test.

Table 5. Based on observations of the number of flowers per plant at 42 days after planting, 56 days after planting, 63 days after planting, 70 days after planting, and 77 days after planting, the combination of 10 kg of goat manure bokashi fertilizer with 20 ml/L of effective microorganism 4 (EM4) produced the highest number of flowers, with an average of 18.22 flowers per plant, at 77 days

after planting. In contrast, the lowest combination of 6 kg of goat manure bokashi with 10 ml/L of effective microorganism 4 (EM4) only produced 17.11 flowers per plant.

Table 6. Average Dry Fruit Weight per Plant in Different Treatments of Goat Manure Bokashi Fertilizer Dosage and Effective Microorganism 4 (EM4) Concentration at Various Ages.

TREATMENT	DRY FRUIT WEIGHT PER PLANT (GR)				
	P1	P2	P3	P4	P5
GROWING MEDIA					
B/6KG	12.05a	19.27a	25.61a	49.97a	71.01a
B/8KG	27.55b	30.57b	37.13b	71.51b	91.31b
B/10KG	29.77b	31.35b	37.80b	76.39b	91.58b
EM4					
10 ML/L	19.29a	21.98a	28.83a	59.97a	77.41a
30 ML/L	25.02a	29.55b	35.83b	68.68b	86.94ab
20 ML/L	25.05a	29.67b	35.89b	69.23b	89.55b

Note: Numbers followed by different letters in the same column indicate a significant difference in the 5% Duncan test.

Table 6. Based on observations of dry fruit weight per plant from five harvests (p1-p5), the combined dose of 10 kg of goat manure bokashi fertilizer with 20-30 ml/L of effective microorganism 4 (EM4) produced the highest dry fruit weight, with an average of 91.58 grams at the fifth harvest, far exceeding the lowest dose of 6 kg of goat manure bokashi with 10 ml/L of effective microorganism 4 (EM4), which only produced 77.41 grams.

3.2. Figures

Figure 1. The results of the analysis of variance in the number of fruits per plant indicate that there is an interaction between the combination of goat manure bokashi fertilizer treatment and the concentration of effective microorganism 4 (BE) on the number of fruits per plant parameter. The average results of observations of the number of fruits per plant are presented in Figure 1.

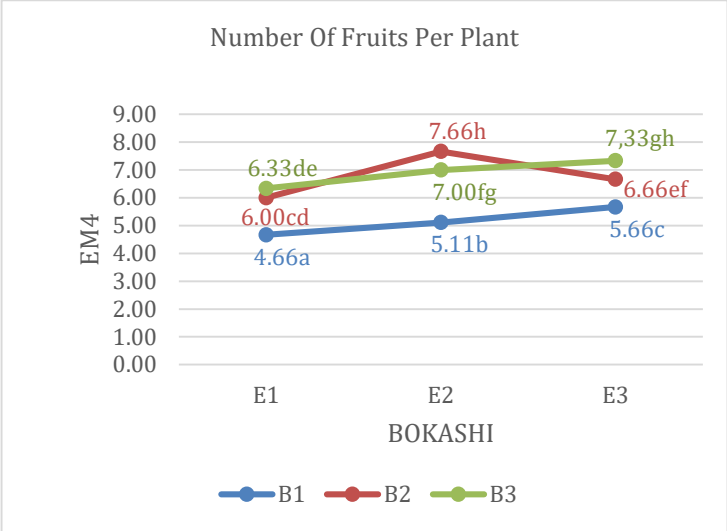

Figure 1. Interaction curve of goat manure bokashi fertilizer dosage and effective microorganism 4 (EM4) concentration on fruit number per plant, observed over 5 times.

Figure 1 shows that the combination of 10 kg of goat manure bokashi fertilizer and effective microorganism 4 (EM4) concentration on fruit number per plant B3E2 resulted in the highest average fruit number per plant, significantly different from the other combinations.

Figure 2. Results of the analysis of variance for fruit diameter per plant indicate an interaction between the combination of goat manure bokashi fertilizer treatment and effective microorganism 4 (BE) concentration on fruit diameter per plant. The average fruit diameter per plant is shown in Figure 2.

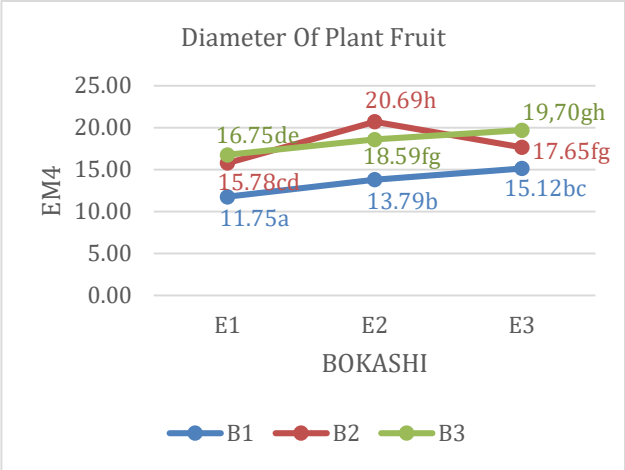

Figure 2. Interaction curve of goat manure bokashi fertilizer dosage and effective microorganism 4 (EM4) concentration on fruit diameter per plant, observed over 5 observations.

Figure 2 shows that the combination of 10 kg of goat manure bokashi fertilizer and effective microorganism 4 (EM4) concentration on fruit number per plant B3E2 and B3E3 resulted in the highest average fruit diameter per plant, significantly different from the other combinations.

Figure 3. Results of the analysis of variance for fruit weight per plant indicate an interaction between the combination of goat manure bokashi fertilizer treatments and effective microorganism 4 (BE) concentration on fruit number per plant. The average fruit weight per plant observations are presented in Figure 3.

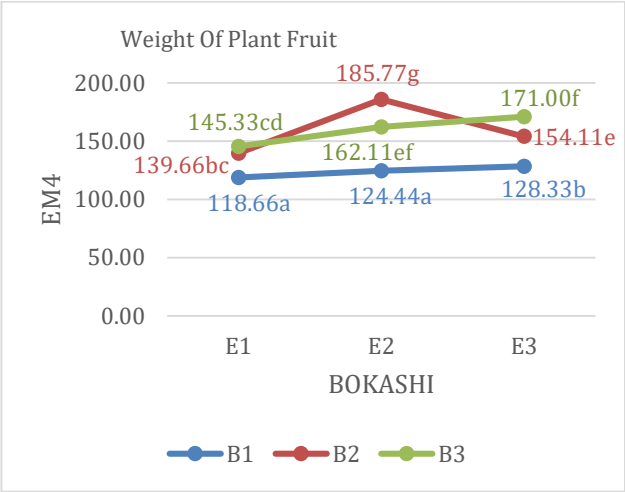

Figure 3. Interaction curve of goat manure bokashi fertilizer dosage and effective microorganism 4 (EM4) concentration on fruit weight per plant, observed five times.

Figure 3 shows that the combination of 10 kg goat manure bokashi fertilizer and effective microorganism 4 (EM4) concentration on fruit weight per plant (B3E2 and B3E3) resulted in the highest average fruit weight per plant, significantly different from the other combinations.

3.3 Discussion

The results of the analysis of variance showed that the combination of goat manure bokashi fertilizer and EM4 concentration impacted eggplant growth and yield. This was particularly true for the number of fruits per plant, fruit diameter, and fruit weight. The combination of 10 kg/plot of goat manure bokashi fertilizer and 20 ml/L EM4 concentration (B3E2) provided the highest results for most growth and yield parameters compared to other treatments with lower concentrations.

The application of 10 kg/plot of goat manure bokashi fertilizer increased soil nutrient availability, particularly nitrogen, phosphorus, and potassium, which are essential macronutrients in the vegetative growth phase. Adequate nitrogen availability supports leaf and stem formation, while phosphorus and potassium support root and vascular tissue formation. This results in improved photosynthetic performance, as stated by (Simanungkalit, 2016), who stated that manure is a primary source of macro and micronutrients that can enhance vegetative plant growth.

An EM4 concentration of 20 ml/L (E2) produced the best average growth and yield compared to other EM4 concentrations. EM4 contains microorganisms such as Lactobacillus sp. and Streptomyces sp., which play a role in accelerating organic matter decomposition and increasing nutrient availability in the soil. This significant effect of EM4 aligns with research (Manuputty, 2018), which states that EM4 application increases nutrient absorption efficiency and promotes optimal plant growth (Pratama1 et al., 2025).

Regarding growth parameters, the B3E2 treatment combination produced the highest plant height of 42.08 cm at 42 days after planting, followed by the B2E2 and B3E3 treatments. This indicates that the combination of high-dose goat bokashi and moderate EM4 concentrations provides an optimal environment for root and stem growth, thus supporting overall plant growth.

Plant leaf area also showed a similar trend, with the B2E2 combination producing the highest leaf area of 2,315.33 cm² at 42 days after planting (DAP). Large leaf area supports optimal photosynthesis, ultimately increasing biomass production and generative outcomes such as flowers and fruit (Sriyanto et al., 2016).

In terms of crop yield, the B3E2 treatment combination demonstrated superiority in the number of flowers per plant, fruit number, fruit diameter, and fruit weight. This combination produced the highest number of flowers, 18.22 flowers per plant, at 77 days after planting. EM4 helps initiate the formation of growth hormones such as auxin and cytokinin, which support the flowering process (Yulhasmir, 2019).

In terms of yield, the B3E2 and B3E3 combination produced the highest fruit diameter of 20.69 mm and the highest fruit weight, reaching 92.00 grams at the fifth harvest. This increased yield indicates that EM4 and goat bokashi have a synergistic effect on plant metabolism during the generative phase. Adequate potassium plays a role in fruit filling and improving yield quality (Safitri, 2017).

Overall, the B3E2 combination treatment was deemed the most effective in supporting eggplant growth and yield. This combination not only yielded high yields but also reflected the efficient use of organic fertilizer and soil microbes for more environmentally friendly and sustainable agriculture (Soemargono et al., 2021).

4. CONCLUSIONS

There is an interaction between the dosage of goat manure bokashi fertilizer and EM4 concentration on eggplant plant yield, especially on the number of fruits, fruit diameter, and fruit weight per plant, while on growth parameters such as plant height, stem diameter, number, and leaf area the interaction is not significant. The combination of goat manure bokashi treatment of 10 kg/plot with EM4 20 ml/l (B3E2) is the most optimal combination because it is able to produce good vegetative growth as well as the highest generative results, including the number of flowers, number of fruits, fruit diameter, and fruit weight. Overall, the administration of high doses of goat manure bokashi (10 kg/plot) and medium concentration EM4 (20 ml/l) proved to be the most effective in supporting the growth and yield of eggplant plants, so it can be recommended for use in sustainable eggplant cultivation.

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