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Assessment of Growth Enhancement Cayenne Pepper with Organic Inducer Biomass and Mycorrhizae

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ABSTRACT
This study aims to determine the effect of the addition of organic inducer biomass and Arbuscular Mycorrhiza Fungi *(AMF) on the vegetative growth of Cayenne pepper (*Capsicum frutescens *l.). The study was conducted in Cupak Village, Kudu District, Jombang Regency, April to July 2025. The research method used was a non-factorial randomized block design (RAK) with 5 treatments and 5 replications. The treatments tested consisted of negative control (k-), positive control (k+), and a combination of BIO (organic fertilizer made from bamboo leaves, goat manure, rice husks, and EM4) and AMF, namely P1 (75% bio + 25% soil + AMF), P2 (50% bio + 50% soil + AMF), and P3 (25% bio + 75% soil + AMF). The parameters observed included plant height, number of leaves, length and fresh weight of roots. Data were analyzed using ANOVA test and continued with Tukey test at 5% level for significant difference test. The results showed that the application of BIO and AMF significantly increased the height of chili pepper plants at 35 and 42 days after planting (DAP). Treatment P3 produced the best results, with plant height reaching 17.9 cm at 42 DAP, a highly significant difference compared to the other treatments. Leaf number, length, and root fresh weight showed a trend toward increasing, but statistical analysis showed no significant differences (p > 0.05). The results indicated that the combination of BIO and AVM has the potential to increase the vegetative growth of chili pepper, particularly plant height compared to the control.*

Keywords*: Organic Inducer Biomass; Arbuscular Mycorrhiza Fungi; Cayenne Pepper; Bamboo Leaves.*

INTRODUCTION
Cayenne pepper (*Capsicum frutescens* l.) are annual vegetables with high economic value and are widely cultivated in Indonesia. It is a horticultural commodity widely cultivated commercially in various tropical countries, including Indonesia (Sholihah *et al.*, 2020). According to the 2020-2023 report from the Jombang Regency Central Statistics Agency (2025), chili production, particularly in Kudu District, experienced a decline in production during the 2020-2022 period. In 2020, production reached 1,112 quintals, then in 2021 it experienced a significant decline of 80 quintals. In 2022, it experienced an increase of around 375 quintals. Therefore, efforts are needed to increase chili productivity.

One way to increase chili plant productivity is to optimize nutrient levels through fertilizer application. Chemical fertilizers are generally used to increase nutrient levels. However, their use has negative consequences if implemented continuously and over a relatively long period of time. These negative impacts cause the soil to deteriorate quickly, become less able to retain water, and become acidic, which can lead to decreased chili plant productivity due to an imbalance of nutrients in the soil (Roidah, 2013). Therefore, efforts are needed to reduce the use of chemical fertilizers by utilizing biomass as an organic inducer, one of which is bamboo leaves.

Bamboo leaves are known to contain nutrients in the form of P of 0.03%, K of 0.67%, C-organic of 12.76%, and N-total of 2.09% (Baroroh & Setyono, 2015). In addition to having beneficial nutrient content, bamboo leaves are also easily obtained because they are spread almost throughout Indonesia. However, nutrients in organic fertilizers are generally released gradually so that the efficiency of their absorption by plants is often not optimal. Therefore, supporting technology is needed to increase the effectiveness of the utilization of these nutrients, one of which is through the application of Arbuscular mycorrhizal fungi. Mycorrhizae form a mutualistic symbiotic relationship with plant roots, thereby expanding the root absorption area through an external hyphal network (Susanti & Yuliana, 2024). This mechanism increases the ability of chili plants to absorb nutrients, especially phosphorus, as well as nitrogen, potassium, and microelements, while also increasing the efficiency of the utilization of organic fertilizers made from bamboo leaves. Research of Susanti (2026) showed that the application of moringa leaf compost with the addition of mycorrhiza optimized the vegetative growth (21 cm) and fresh root weight (3.8 – 4.2 gr) of chili plants compared to without the addition of both at the age of 28 days after planting. Thus, the combination of organic bamboo leaf fertilizer and mycorrhiza has the potential to reduce dependence on inorganic fertilizers while supporting the growth and productivity of chili plants sustainably. The aim of this study was to determine the effect of adding organic inducer biomass and Arbuscular Mycorrhiza Fungi (AMF) on the vegetative growth of Cayenne pepper (*Capsicum frutescens* l.).

METHOD

This research was conducted in Cupak Village, Kudu District, Jombang Regency, East Java, Indonesia, from April to July 2025. The study used a quantitative approach with a nonfactorial Randomized Block Design (RBD). The study consisted of five treatments with five replications, resulting in 25 experimental units. Each experimental unit consisted of three chili plants cultivated in polybags containing 2 kg of growing medium. The treatments included: (K−) soil without AMF and organic inducer biomass; (K+) soil inoculated with 10 g AMF; (P1) AMF with 75% organic inducer biomass and 25% soil; (P2) AMF with 50% organic inducer biomass and 50% soil; and (P3) AMF with 25% organic inducer biomass and 75% soil.

The organic inducer biomass (BIO) was made from a mixture of fermented goat manure, bamboo leaves, rice husks, and EM4. The composting process is carried out for approximately 17 days by maintaining the moisture of the material until the compost shows a dark brown color, has a crumbly texture, and smells like soil, which indicates that the compost is mature (Table 1).

Table 1. Composition of organic inducer biomass (BIO)

Ingredients	**Dosage**
Bamboo leaves	2kg
Goat manure	2kg
soil	2kg
Rice husk	1kg
Em4 + aquadest	250ml/1L

The planting medium was prepared one week before transplanting. The Ori 212 Cayenne pepper seedlings were transferred into polybags, then inoculated with AMF and applied BIO according to the established treatment. Plant maintenance included twice-daily watering, manual weeding, and regular observations throughout the study period. Growth observations were conducted from 7 to 42 Days After Planting (DAP). Observed parameters included plant height (cm), number of leaves (leaflets), root length (cm), and root fresh weight (gr). Plant height and leaf number were measured weekly, while root length and root fresh weight were measured at the end of the study.

The data obtained were analyzed using one-way analysis of variance (ANOVA). If the analysis results indicated a significant difference between treatments ($p < 0.05$), a Tukey Honestly Significant Difference (HSD) test was performed to compare the means of each treatment. All statistical analyses were performed using Jamovi software..

RESULT AND DISCUSSION

Result

The application of Organic Biomass Inducer (BIO) combined with Arbuscular Mycorrhiza Fungi (AMF) produced different responses to the vegetative growth of Cayenne pepper plants (Table 2).

Table 2. Average Height of Cayenne pepper Plants Tested

Treatment	Average Chili Pepper Plant Height (cm)*					
	7 DAP	14 DAP	21 DAP	28 DAP	35 DAP	42 DAP
K+	6.30 a	9.10 ab	13.90 b	14.80 b	15.9 b	16.6 ab
K-	6.10 a	8.20 a	11.70 a	13.00 a	14.3 a	15.4 a
P1	6.30 a	8.64 a	11.50 a	12.80 a	14.9 ab	16.6 ab
P2	6.40 a	8.78 ab	11.30 a	12.80 a	14.5 ab	16.2 ab
P3	7.00 b	9.44 b	13.20 b	14.60 b	16.8 c	17.9 b

Description: K+ = control soil inoculated with 10 g MVA, K- = soil without MVA and organic inducer biomass, P1 = MVA with 75% organic inducer biomass and 25% soil, P2 = MVA with 50% organic inducer biomass and 50% soil, P3 = MVA with 25% organic inducer biomass and 75% soil; DAP = days after planting; numbers followed by the same letter in the same column indicate no significant difference according to the Tukey test at 5% level; * = Source jamovi (version 2.7.13.0)

In Table 2, the positive control treatment K+ showed more optimal growth performance with a final value of 16.6 at 42 DAP. Meanwhile, the negative control (K-), only reached a value of 15.4 at the end of the observation at 42 DAP. In treatments P1 and P2, the growth of chili plants tended to be homogeneous and parallel throughout the observation. At the end of the observation (42 DAP), P1 managed to match the K+ gain (16.6 cm), compared to P2 (16.2 cm). The most optimal and consistent growth in each observation was produced by treatment P3. This treatment has dominated since the age of 7 DAP with a height of 7.00 cm to 17.9 cm at 42 DAP.

Table 3. Analysis of plant height diversity at 35 and 45 DAP. ANOVA (Welch's)

Parameter observation	F	df1	df2	p
Plant height 35 DAP	5.33	4	9.86	0.015
Plant height 42 DAP	4.82	4	9.93	0.020

Source: jamovi(versi 2.7.13.0)

Table 3 shows the results of the analysis of variance of treatments that significantly affected plant height at 35 and 42 Days After Planting (DAP). The ANOVA significance values were $p = 0.015$ at 35 DAP and $p = 0.020$ at 42 DAP, respectively. These results indicate that the application of organic biomass inducer and MVA can increase plant growth in the advanced vegetative phase. Among all treatments, P3 produced the highest plant height, namely 17.9 cm at 42 DAP. In contrast, the negative control (K−) produced the lowest average plant height, namely 15.4 cm. Treatments P1 and P2 also showed increased plant growth, but were not statistically significantly different compared to the positive control (K+).

The results of observations on the number of leaves on the tested cayenne pepper plants are shown in Table 4.

Table 4. Average Number of Leaves on the Tested Cayenne Pepper Plants

Treatment	Average Number of Leaves (leaflet)*					
	7DAP	14 DAP	21 DAP	28 DAP	35 DAP	42 DAP
K+	5.0a	5.2a	6.4a	6.0a	6.8a	7.0a
K-	5.0a	5.2a	6.0a	7.0a	7.2a	7.2a
P1	4.8a	5.2a	6.2a	7.0a	7.0a	7.2a
P2	6.0a	6.0a	6.2a	6.8a	7.2a	7.2a
P3	6.0a	6.0a	7.0a	7.0a	7.2a	7.2a

Description: K+ = control soil inoculated with 10 g MVA, K- = soil without MVA and organic inducer biomass, P1 = MVA with 75% organic inducer biomass and 25% soil, P2 = MVA with 50% organic inducer biomass and 50% soil, P3 = MVA with 25% organic inducer biomass and 75% soil; DAP = days after planting; numbers followed by the same letter in the same column indicate no significant difference according to the Tukey test at 5% level; * = Source jamovi (version 2.7.13.0)

Table 4 shows a general increase in leaf number from 7 to 42 days after planting in all treatments. However, the analysis showed no significant differences between the treatments at any observation time. The length and fresh weight of the tested chili plant roots are shown in Table 5 below:

Table 5. Average Length and Fresh Weight of Chili Plant Roots Tested at 42 DAP

Treatment	Length of root (cm)	Fresh weight of root (gr)
K+	7.60	0.50
K-	6.40	0.37
P1	6.6	0.48
P2	9.40	0.48
P3	8.00	0.71

Description: K+ = control soil inoculated with 10 g MVA, K- = soil without MVA and organic inducer biomass, P1 = MVA with 75% organic inducer biomass and 25% soil, P2 = MVA with 50% organic inducer biomass and 50% soil, P3 = MVA with 25% organic inducer biomass and 75% soil; DAP = days after planting; numbers followed by the same letter in the same column indicate no significant difference according to the Tukey test at 5% level; * = Source jamovi (version 2.7.13.0)

Table 5 shows that plants without additional fertilizer or Negative Control (K-) produced the lowest root growth, namely with a length of 6.40 cm and a weight of 0.370 grams, compared to k+ and treatment 1 (p1). In treatment P2, which produced the longest roots reaching 9.40 cm, but had a relatively light wet weight (0.484 grams). The highest root length in treatment P2 indicates an adaptive response of the plant in increasing root exploration of available nutrient sources. Treatment P3 showed the most optimal performance overall. Although its root length (8.00 cm) was below P2, treatment P3 produced the highest wet root weight of 0.712 grams, even surpassing the Positive Control (K+) which used standard commercial fertilizer (0.502 grams).

Table 6. ANOVA data for length and fresh weight of root Cayenne pepper

Parameter observation	F	df1	df2	p
Length of root	0.534	4	9.49	0.714
Fresh weight of root	1.31	4	9.81	0.333

Based on the results of one-way variance analysis using Welch's robust ANOVA test, For the root length parameter, the resulting F coefficient value was 0.534 with a significance value (p) of 0.714. Meanwhile, for the root wet weight parameter, the F coefficient value was recorded at 1.31 with a significance value (p) of 0.333 (Table 6). The significance value for both parameters was much greater than the specified critical threshold ($p>0.05$), so statistically it was concluded that all variations of the nutritional treatments tested did not have a significant effect (not significantly different) on the length or wet weight of chili plant roots, so data analysis for these two parameters did not need to be continued with further testing (Post-Hoc Test).

Discussion

The significant increase in plant height at the P3 treatment indicates that the combination of BIO and MVA can enhance plant vegetative growth. Organic biomass inducer plays a role in improving soil structure and increasing nutrient availability. The inducer material, bamboo leaves, contains 0.03% P, 0.67% K, 12.76% organic C, and 2.09% N total (Baroroh & Setyono, 2015). These leaves have the potential to be used as a base material for compost (Wahyudi et al., 2025). Rice husks contain the nutrient silicon (Si), which plays a role in root elongation and dry weight (Gian et al., 2021). Goat manure was chosen because it contains macro (N, P, and K) and micro (Ca, Mg, P, Na, Fe) nutrients which are important for plant growth and maintaining soil fertility (Rimbanu *et al*., 2025; Qibtiyah *et al*., 2021).
Meanwhile, AMF increases phosphorus absorption through an extensive hyphal network (Susanti *et al*., 2018). The available phosphorus can stimulate cell division, chlorophyll synthesis, and stem elongation, resulting in more optimal plant height growth. The superiority of the P3 treatment indicates that the composition of 25% BIO and 75% soil is able to provide a balanced planting medium to support microbial activity as well as the development of the plant root system. The use of organic matter in excessive amounts has the potential to cause temporary nutrient immobilization during the decomposition process, while the appropriate proportion allows for the gradual release of nutrients according to plant needs.

Although the treatment did not significantly affect the number of leaves, root length, or root fresh weight, all parameters showed an increasing trend. These results are consistent with previous studies that reported that AMF can increase nutrient absorption, although it does not always produce significant differences in each vegetative growth parameter. Variations in environmental conditions, nutrient availability, and the length of the observation period are thought to influence the magnitude of the plant's response to the treatment. In the average results, the number of leaves in Cayenne pepper plants did not immediately increase significantly. It happened because BIO organic fertilizer is slow-release or releases food (nutrients) slowly and gradually. Its effect on leaf number is not yet clearly visible in the early stages of growth. Rimbanu et al. (2025) reported that manure is slow-release, where the elements contained in the fertilizer are released slowly and continuously over a long period.

Overall, the results of this study indicate that integrating organic inducer biomass with AMF is a promising strategy to support sustainable chili cultivation. In addition to its potential to help increase plant growth, it also reduces dependence on synthetic fertilizers and enhances efforts to utilize environmentally friendly bamboo organic waste (Karim et al., 2023).

CONCLUSIONS

The addition of 25 percent organic inducer biomass (BIO) made from bamboo leaves, supported by 10 grams of AMF, can increase the vegetative growth of Cayenne pepper (*Capsicum frutescens* l.) to around 17.9 cm at 42 days after planting. Meanwhile, the average number of leaves, length, and fresh root weight in each treatment showed no significant differences.

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