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# Mycorrhizal Application and Dosage Material Organic Towards Increasing Chili Pepper Production (*Capsicum frutescens*) on Goal Plant Cocoa

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**Abstract**

Cayenne pepper is a horticultural commodity with high economic value and is widely cultivated by farmers across various regions in Indonesia. In addition to household consumption, cayenne pepper serves as a raw material for the food and beverage industry. Its nutritional content, including vitamin C, vitamin A, lycopene, and various antioxidants, makes this plant important from both health and economic perspectives. However, productivity at the farmer level faces several challenges, including limited use of fertilizers and sustainable organic materials. Excessive reliance on chemical fertilizers can degrade soil fertility and harm the environment. Therefore, the use of organic materials, such as liquid organic fertilizer (POC), and growth-promoting fungi, such as mycorrhizae, offers an environmentally friendly alternative with the potential to increase crop production. This study aimed to determine the effects of different types of organic fertilizers used by farmers, specifically mycorrhizae and POC, and their interactions on cayenne pepper production. The experiment employed a 4 × 3 factorial randomized block design (RBD) with three replications, yielding 12 treatment combinations across two factors. The results showed that mycorrhizae had a significant effect on plant height at 15, 30, and 45 days after planting (DAP), as well as on fresh weight at 110 DAP, but no significant effect on other parameters. Additionally, there was no significant interaction between mycorrhizae and POC doses on any observed parameters. Among the mycorrhizal types tested, Glomus mosseae consistently produced better results compared to other mycorrhizal types throughout the observation period on cayenne pepper plants.

**Keywords:** Concentrate Organic, Fertilizer Hayati, Glomus Moseae, Growth Chili, Results Chili

## 1. Introduction

Cayenne pepper (*Capsicum annuum* L.) is a horticultural crop belonging to the Solanaceae family (Weihan et al., 2024). It has high economic value and contains several essential nutrients, including protein, fat, carbohydrates, calcium, and vitamins A and C, making it a widely used commodity in cooking (Wahyudin Purba & Padhilah, 2021).

Production of cayenne pepper in Indonesia has fluctuated over the past five years. In 2013, cayenne pepper production was 1.01 million tons. (Djam et al., 2024), It then increased to 1.07 million tons in 2014 but decreased to 1.04 million tons in both 2015 and 2016. In 2017, production rose again to 1.20 million tons. In Aceh, cayenne pepper production in 2017 was only 53,041 tons, according to the Ministry of Agriculture of the Republic of Indonesia in 2018. Consumption of cayenne pepper continues to increase annually due to population growth. Unpredictable weather, pest infestations, diseases, viruses, and fungi cause the decline in quality and instability in cayenne pepper production. (Syaifullah, 2016). Therefore, cultivating cayenne pepper requires optimal care and appropriate environmental conditions (Tando, 2019).

One of the main challenges in chili cultivation is low soil fertility due to unsustainable land management. Long-term excessive use of inorganic fertilizers has led to the degradation of the soil's physical, chemical, and biological properties. (Maulana et al., 2025) . The soil becomes hard,

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organic matter levels decrease, and beneficial soil microbial activity is significantly reduced. This condition results in suboptimal nutrient absorption by plants, thus limiting chili growth and production. (Ranesa et al., 2020). Therefore, a more environmentally friendly and sustainable cultivation approach is needed, such as the use of soil microorganisms that form a symbiosis with plant roots (mycorrhiza) and liquid organic fertilizer (POC) derived from natural materials. (Paridawati et al., 2024) .

In increasing production, farmers generally prefer chemical fertilizers; however, long-term use of these fertilizers often has a negative impact on living organisms and the surrounding environment. (Wirda et al., 2023) . Therefore, environmentally friendly organic fertilizers are needed (Maulana, Zuhra, et al., 2024).

This symbiosis has been shown to increase the efficiency of macronutrient absorption, such as phosphorus (P), nitrogen (N), and potassium (K), as well as micronutrient absorption, such as zinc (Zn) and copper (Cu). Furthermore, mycorrhizae also play a role in increasing plant resistance to abiotic stresses, such as drought, salinity, and root pathogen attacks. In chili cultivation, mycorrhizae have significant potential to increase vegetative growth, flower formation, fruit number, and overall yield. Mycorrhiza is a fungus that lives in mutualistic symbiosis with plant roots, where the fungus obtains carbohydrates from the host plant, while the plant gains increased ability to absorb water and nutrients from the soil. (Maulana, Pratiwi, et al., 2024) . Administration of AMF (arbuscular mycorrhizal fungi) to horticultural plants significantly affects the incubation of fusarium wilt disease (Maulana, Safriani, et al., 2024). In the research (Maulana et al., 2024), the application of AMF (arbuscular mycorrhizal fungi) to chili plants can delay the emergence of yellow leaf curl disease in chilies caused by Begomovirus. Furthermore, mycorrhizal fungi can also increase soil fertility. In research (Maulana & Erwin Harahap, 2023), Mycorrhizal fungi are a type of fungus that play an important role in maintaining soil fertility by increasing nutrient uptake (N, P, K) and water absorption. (Maulana & Noer, 2025) and increase resistance to drought and soil microbial activity (Maulana et al., 2022).

The integration of mycorrhizae and organic fertilizers (POC) in chili cultivation systems is seen as a synergistic strategy. Mycorrhizae extend root length to absorb nutrients from the soil, while POC increases nutrient availability and improves soil conditions, thereby supporting mycorrhizal growth. (Depi, 2022) . The combination of the two is expected to create a more efficient root system, increase nutrient availability, and support vegetative growth. (Ali, 2025) and optimal generative chili plants. Furthermore, the use of these two materials can reduce dependence on chemical fertilizers, which are not only expensive but also have the potential to degrade environmental quality if used excessively. (Maulana et al., 2021) .

Research on the application of mycorrhizae and POC on horticultural crops, including chilies, has been widely conducted and has shown promising results. (ARANI, 2006) . Several studies report that mycorrhizal inoculation can increase plant height, leaf number, leaf area, and dry weight of roots and shoots of chili plants. Meanwhile, the application of Liquid Organic Fertilizer (POC) has been shown to increase chlorophyll content, flower number, and fresh fruit weight per plant. However, the effect of combining mycorrhizae and POC on chili productivity has not been studied in depth, especially under suboptimal soil conditions such as sandy or acidic soils commonly found in coastal areas of Aceh and other tropical regions. (Nasution, 2019) .

Environmental factors such as water availability, soil pH, and soil fertility levels can influence the effectiveness of mycorrhizae and POC. (Sari et al., 2024) . Mycorrhizae are more active in loose soil with sufficient organic matter, while POC yields the best results when applied regularly at the correct dosage and concentration. (Karomah, 2022) . Therefore, research on the interaction between these two factors is necessary to determine the optimal treatment combination to enhance chili plant growth and yield. (Chairunnisak et al., 2023) .

In addition to agronomic aspects, the use of mycorrhizae and POC also has high ecological and economic value. From an ecological perspective, the use of these natural materials can reduce soil and water pollution from chemical fertilizer residues while increasing the diversity of soil microbes, which play an important role in nutrient cycling. From an economic perspective, the use of mycorrhizae and POC can reduce farmers' production costs because these materials can be obtained locally at low prices and even produced by farmer groups themselves. Thus, agricultural systems that utilize mycorrhizae and POC can be categorized as sustainable, appropriate technology. Based on the above problems, research is needed to determine the effectiveness of the mycorrhizal fungus type and the optimal dosage of Trichoderma harzianum pellets in suppressing Fusarium wilt and increasing chili plant production.

This study evaluates the influence of mycorrhizal application on nutrient absorption and the growth of cayenne pepper plants cultivated on nutrient-poor cocoa plantation soils. It assesses the effects of varying doses of organic materials on nutrient availability and cayenne pepper productivity. Additionally, the interaction between mycorrhiza and organic material doses is analyzed to determine their combined impact on soil fertility and cayenne pepper yield in cocoa plantation areas. The study aims to identify the most effective combination of mycorrhiza and organic material dosage to overcome nutrient deficiencies and maximize cayenne pepper production.

## 2. Material and Methods

### 2.1. Place and Time of Research

This research will be conducted at PEMA Farm Research and Business Center, BTN Kupula Indah Complex, located in Kota Juang District, Bireuen Regency, Aceh Province. One of the coordinates recorded for this complex is 5°11'52" North Latitude and 96°43'8" East Longitude. The altitude of this place is estimated to be around 20 meters above sea level (MDPL), Kota Juang, and the Laboratory of the Faculty of Agriculture, University of Medan, from March to June 2025.

### 2.2. Materials and tools

The materials used were 10% KOH, 50% alcohol, dye (Quink Parker), chili seeds of the variety (Kharisma), mycorrhizal fertilizer (Glomus sp. and Gigaspora), and Trichoderma Harzianum pellets obtained from the Soil Biology laboratory of Syiah Kuala University.

The tools used in this study were 15 kg polybags, trays, meters, watering cans, analytical scales, soil sieves, hoes, Nikon SE 102 binocular microscopes, petri dishes, sieves, tweezers, slides, cover slips, ovens, cameras, and plastic houses for placing the experimental polybags.

### 2.3. Research methods

The design used in this experiment was a 4 × 3 Factorial Randomized Block Design (RAK) with 3 replications, so that it had 12 treatment combinations consisting of two treatment factors:

The first factor is the type of Mycorrhiza (M), with 4 levels: Control, Glomus sp. Mycorrhiza 10g, Gigaspora sp. Mycorrhiza 10g and Mixture 10g. The second factor is the POC dose, which consists of 3 levels: Control, Dose 10 ml, Dose 20 ml

### 2.4. Research Implementation

#### 2.4.1. Chart flow study

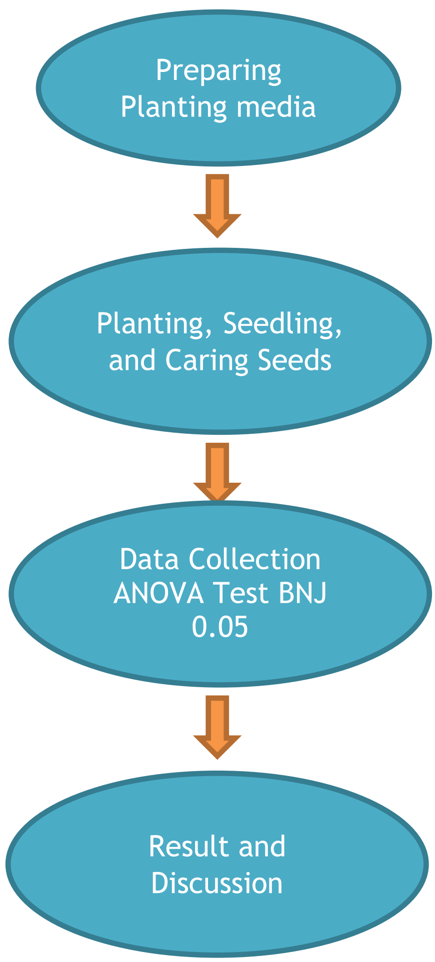


**Figure 1.** Research flow diagram

1. Preparation of Planting Media

Soil was taken from the topsoil layer to a depth of 0–25 cm. It was then sieved using a 2 mm sieve. The soil was placed into 15 kg polybags and arranged according to the treatment plan.

2. Mycorrhizal Application Treatment

Each polybag was inoculated with mycorrhizae for its species, and a control (without mycorrhizae) was included. The mycorrhizae were placed in the planting holes around the root zone at a depth of 2-3 cm, depending on the treatment per plant, before the seeds were planted in the polybags. The holes containing the mycorrhizae were then covered with soil. Mycorrhizae were applied once at the time of seed planting.

#### 2.4.2. Observation Variables.

1. Number of fruits per plant (fruits)

Observations were made at harvest time at 90, 95, 100, 105, and 110 days after planting by counting the total number of red chilies.

2. Fruit weight per plant (g)

Fruit weight was measured at harvest time, at the ages of 90, 95, 100, 105, and 110 HST, by weighing the chilies per plant on an analytical scale.

3. Wet weight of shoots per plant (g)

After 110 days of planting, the plant is weighed, dismantled, cleaned of roots with water, aired for a while, and then weighed again using an analytical scale.

4. Wet weight of roots per plant (g)

After 110 days of planting, the roots are cut at the base of the stem, cleaned with water until the sticky soil is removed, and weighed using an analytical balance.

### 2.5. Data Analysis

Data analysis was performed using Microsoft Excel Professional Plus 2019, and manual data collection was conducted.

## 3. Results and Discussion

### 3.1. Number of fruits

The results of the F test in the analysis of variance showed that the type of mycorrhizae had a very significant effect on the number of fruits 110 days after planting. The average number of fruits 110 days after planting for various types of mycorrhizae is shown in Table 1.

**Table 1.** Average number of fruit at 110 HST in various mycorrhizal treatments

| Mycorrhizal type (10 g/plant) | Number of Fruits |
|---|---|
| Control | 4, 6 8b ±0.45 |
| *Glomus* | 3.5 a ±0.45 |
| *Gigaspora* | 8, 0 1b ±0.45 |
| Mixture | 7.10 b ±0.45 |
| BNJ $_{0.05}$ | 1,569 |

Table 1 shows that the average number of fruits per plant tends to be higher in the *gigaspora mycorrhizal type* (7.11), and statistically, there is no significant difference between the mixed mycorrhizal type (6) and the control type (6.88).

This finding aligns with research showing that mixed mycorrhizal species (Glomus and Gigaspora) typically exhibit good adaptability and growth in polluted and tropical environments. (Alfiyah, 2015). This finding is consistent with research showing that plants with mycorrhizal associations exhibit higher nutrient absorption of N and P. (Permanasari et al., 2016) because mycorrhizae will encourage the development of hyphae in plant roots. Mycorrhizae increase the absorption of P and N, which are important nutrients for flower and fruit formation. This effect is also correlated with increased levels of growth hormones, such as cytokinins and auxins, which stimulate the plant's generative processes.

### 3.2. Fruit Weight per Plant (g)

The results of the F test in the analysis of variance showed that the mycorrhizal type treatment had no significant effect on fruit weight per plant at 110 days after planting. The average fruit weight per plant across various mycorrhizal types is shown in Table 2.

**Table 2.** Average fruit weight per plant at 110 days after planting in various mycorrhizal treatments

| Mycorrhizal type (10 g/plant) | Fruit Weight Per Plant |
|---|---|
| Control | 10, 2 6a ±1.53 |
| *Glomus* | 30 .1 6 b ±1.53 |
| *Gigaspora* | 2 2, 4 1b ±1.53 |
| Mixture | 3 4, 2 5b ±1.53 |
| BNJ $_{0.05}$ | 5,306 |

Table 2 shows that the average fruit weight per plant is higher in the mixed mycorrhizal type (31.05) and lowest in the control (8.66).

Mixed mycorrhiza (Glomus mosseae and Gigaspora sp.) has a high level of adaptation to polluted areas with various types of mycorrhiza (Gloria et al., 2016). The results of this study show that *Trichoderma* significantly affected stem diameter at 30 days after planting and fruit number at 110 days after planting. It had a significant effect on chili plant growth. The best *Trichoderma Harzianum results were found at* a dose of 10 grams. This finding is in line with Kusuma (2016), who stated that Trichoderma Harzianum has many advantages compared to control plants; therefore, the use of Trichoderma Harzianum doses can increase production in both quantity and quality, as well as the level of resistance to plant pest attacks and the response to fertilization.

A mixture of two types of mycorrhizae can adapt better to tropical and polluted soil conditions, and form more numerous and extensive hyphae than a single mycorrhizae. This result leads to increased nutrient absorption, such as K and P, which are important for fruit formation and growth.

### 3.3. Wet Weight of Planting Stalks (g)

The results of the F test in the analysis of variance showed that the type of mycorrhizae had a very significant effect on the fresh weight of the berangkasan at 110 days after planting. The average fresh weight of the berangkasan across various mycorrhizal treatments is shown in Table 3.

**Table 3.** Average fresh weight of seedlings at 110 HST in various mycorrhizal treatment types

| Mycorrhizal type (10 g/plant) | Fruit Weight Per Plant |
|---|---|
| Control | 3 5.2 1 a ±3.06 |
| *Glomus* | 3 6, 2 3a ±3.06 |
| *Gigaspora* | 9 0.88c ±3.06 |
| Mixture | 65 , 6 8ab ±3.06 |
| BNJ $_{0.05}$ | 10.58 |

Table 3 shows that the average wet weight of chili plant shoots tends to be heavier in the *gigaspora mycorrhizal type* (70.88), although it is not significantly different from the other mycorrhizal treatments.

This finding aligns with the research (Fawziah, 2021). Previously, the growth and yield of chili plants, including wet plant weight, dry plant weight, fruit weight per plant, number of fruits, yield potential, and root colonization, were found to be highest at a mycorrhizal dose of 10g/plant.

Application can increase plant weight in both fresh and dry forms in cayenne peppers and help reduce disease symptoms by increasing plant physiological resistance. Furthermore, it was reported that arbuscular mycorrhizae can improve plant growth under saline soil stress by increasing root and aboveground plant tissue colonization.

### 3.4. Wet Weight of Plant Roots (g).

The F test in the analysis of variance showed that the type of mycorrhizae had no significant effect on shoot fresh weight at 110 days after planting. The average root weight per plant across various mycorrhizal treatments is shown in Table 4.

**Table 4.** Average wet weight of 110 HST in various types of mycorrhizal treatments

| Mycorrhizal type (10 g/plant) | Fruit Weight Per Plant |
|---|---|
| Control | 1 4 , 21 ab ±1.14 |
| *Glomus* | 1 1 .44a ±1.14 |
| *Gigaspora* | 3 4, 3 6d ±1.14 |
| Campuran | 1 6 BC ±1.14 |
| BNJ $_{0.05}$ | 3,961 ±1,14 |

Table 4 shows that the average wet weight of chili plant roots tends to be heavier in the *Gigaspora mycorrhizal type* (24.66), while the *Glomus mycorrhizal type* only weighs 13.44, and a mixture (18). The results of the research conducted show that the type of mycorrhizal has a significant effect on the number of fruits at 110 HST, stem diameter at 30 HST, and has a very significant effect on the height of chili plants at 15, 30 and 45 HST, the number of leaves per plant at 15, 30 and 45 HST, but has no significant effect on stem diameter at 15 HST. The best growth and yield of chili plants are achieved with the Gigaspora mycorrhizal type at 10 g/plant. This finding is in line with previous research (Hadianur et al., 2017), which showed that the growth and yield of chili plants, such as parameters of wet plant weight, dry plant weight, fruit weight per plant, number of fruits, yield potential, and root colonization in chili plants, were found at a mycorrhizal dose of 10g/plant.

Mycorrhizae increase lateral root formation and main root length, as well as root fresh weight, in okra and chili plants. The increase in root weight also indicates that mycorrhizae increase soil microbial activity and improve soil structure.

## 4. Conclusion

The type of mycorrhizae had a highly significant effect on the number of fruits per plant at 110 days after planting. The best growth and yield of chili plants were observed with Gigaspora sp. mycorrhizae. However, the application of Trichoderma did not significantly affect any yield parameters; the best combination for the number of leaves per chili plant at 15 days after planting and stem diameter at 30 days after planting was achieved with a 10 g dose.

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