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Performance of Cayenne Pepper (*Capsicum frutescens* L.) Application of FMA and Organic Matter under Saline Conditions

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Abstract

Cayenne pepper (*Capsicum frutescens*) is a promising commodity for development in Indonesia, and it is known for its high market value. It belongs to the Solanaceae family, which includes eggplants. This study aims to determine the effects of arbuscular mycorrhizal fungi (AMF) and organic material dosage and the interaction between these two factors on the growth and yield of cayenne pepper plants. The design used in this experiment was a 3 × 4 Factorial Randomized Block Design (RAK) with 3 replications so it had 12 treatment combinations consisting of two treatment factors. The first factor is AMF (F) which consists of 3 levels: Control, Glomus Moseae and Gigasspora. The second factor is the Organic Material Dosage of 4 levels: control, 100 ml/L, 150 ml/L, 200 ml/L—research Results 1. The application of AMF did not significantly affect several observation parameters, namely plant height, stem diameter, number of leaves, number of fruits, fruit weight, wet shoot weight and percentage of roots infected with mycorrhiza. The Organic Material Dosage significantly affected root infection at 45 HST but did not significantly affect other parameters. The best combination of root interaction at 45 HST was found at an Organic Material dose of 150 ml/L. There was a significant interaction between AMF and the Organic Material dose on stem diameter and wet shoot weight.

Keywords: Cayenne Pepper, Dosage, FMA, Mycorrhiza, Organic Matter

1. Introduction

Cayenne pepper (*Capsicum frutescens* L.) is a commodity promising to be developed in Indonesia with a high sales value. (Trianziani, 2020) . Cayenne pepper belongs to the Solanaceae or eggplant family. (Setiyani et al., 2023) . Cayenne pepper originates from Mexico, Peru and Bolivia. The optimal environment for growing this type of plant is in highland areas with low humidity. The ideal low temperature is 15˚C to 25˚C to grow this subtropical plant (Ketut, 2020) .

Domestic cayenne pepper market opportunities and abroad are still auspicious because the existing supply is smaller than the demand received. The average demand from abroad or exports reaches ± 100 tons week-1, while Indonesia can only meet 26 tons week-1. The average domestic demand is estimated at 105 kg week-1. Specifically for the modern market, it is 35 kg week-1. The development of the cayenne pepper market in Indonesia from 2009 to 2014 increased, and there was a slight decline in 2011.

In 2016, the production of cayenne pepper was only 5,256 tons. In 2017, it increased to 7,390 tons; in 2018, it increased drastically to 18,151. In 2019, it also increased to 19,358 tons; in 2020, it decreased to 17,822 tons. Saline conditions are a serious problem for farmers around the coastline, so a cultivation model is needed to overcome the saline problem and reduce the production of cayenne pepper plants. Based on these data, cayenne pepper cultivation can be carried out to meet the increasing market demand for cayenne pepper to meet food needs (Wardhana et al., 2022). Fertilizing is the optimal way to increase cayenne pepper production. One of the fertilizers used is biological fertilizer, which can encourage growth and increase agricultural yields. Innovative technology is needed to utilize AMF (Arbuscular Mycorrhizal Fungi), especially with saline stress.

Saline stress is an environmental factor affecting plant growth and yield, including cayenne pepper plants (

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Capsicum frutescens). High salinity can cause osmotic stress that disrupts the balance of water and nutrients in plants. Plants exposed to saline stress experience decreased photosynthesis ability, reduced chlorophyll content, and damage to the root system, inhibiting their growth. (Karolinoerita & Annisa, 2020) . In addition, salinity also increases the accumulation of sodium (Na+) and chloride (Cl-) ions, which damage cell structure and disrupt plant metabolism. (Nematoda et al., 2024) . However, some cayenne pepper varieties can adapt to saline stress with osmoregulatory mechanisms such as proline accumulation and synthesis of other compounds that help maintain cell turgor. (Adolph, 2016) . Research conducted by (SHELEMO, 2023) showed that providing fertilizer containing calcium can reduce the negative impact of salinity on the growth of cayenne pepper. Therefore, this study reveals that understanding the mechanism of salinity resistance in cayenne pepper is very important for the development of varieties that are more tolerant to saline stress, especially using the help of mycorrhizal fungi to be able to adapt, especially in areas with high salinity.

The symbiotic relationship of mycorrhizae with roots does not change the morphological appearance of the roots but changes the composition of cells and root tissues. As many as 80% of angiosperm plants are hosts for arbuscular mycorrhizal fungi.

The type of mycorrhizal fungi has a very significant effect on the wet shoot weight of the vegetative and generative phases, the fresh root weight of the vegetative and generative phases, the dry shoot weight of the vegetative and generative phases, the dry root weight of the vegetative and generative phases, the length of the vegetative phase roots and the potential yield of plant-1, and has a significant effect on the length of the generative phase roots, also affects the absorption of P and N nutrients and the colonization of mycorrhizal fungal infections in the roots (Maulana et al., 2022).

Differences in the tolerance mechanisms of each variable or the genetic factors of the variety can cause the differences in response that each variable has in each array. (Maulana & Erwin Harahap, 2023) . The use of superior varieties with benchmarks of maximum growth potential, germination power, vigor index, simultaneity and relative growth rate, seedling height, stem diameter and wet and dry shoot weight with the time required to reach 50% of total germination.

Organic material is a solution that results from the decomposition of organic materials originating from plant remains and animal waste, which contains more than one nutrient element. (Maulana, Zuhra, et al., 2024) . Onion skin has the potential to be used as liquid organic fertilizer because many people have not utilized onion skin, onion skin is used as liquid organic fertilizer because the use of onions which are widely used primarily as cooking spices, also produces a lot of waste from onion skin. Hence, waste is helpful for soil and plant fertility. According to (Eureka Anugrah et al., 2022)

The raw material for liquid organic fertilizer that is very good is wet organic material or organic material with a high water content, such as leftover fruits and vegeTable waste. Liquid organic fertilizer can be made from several types of organic waste: fresh vegeTable waste, stale vegeTable waste, leftover rice, fish, chicken, egg shells, and fruit waste such as grapes, orange peels, apples and others. (Asmawanti S et al., 2022) In this study, the organic materials used have become mixed organic fertilizers that have been fermented into organic solutions .

Based on the description, it is necessary to research whether the provision of AMF and the dose of Organic Fertilizer (Organic Material) affect the growth and yield of cayenne pepper plants and the interaction between the two factors.

2. Material and Methods

2.1. Time and Place

This research will be conducted at the PEMA Farm Research and Business Center, BTN Kupula Indah Complex, located in Kota Juang District, Bireuen Regency, Aceh Province. One of the recorded coordinates for this complex is 5°11'52" North Latitude and 96°43'8” East Longitude. The height of this place is estimated to be around 20 meters above sea level (MDPL), City of Struggle and the Faculty of Agriculture Laboratory, University of Medan Area, from March to June 2024.

2.2. Tools and Materials

The tools used in this study were hoes, watering cans, marker stakes, stationery, sacks, 10 kg polybags, hand sprayers, electron microscopes, Petri dishes, measuring cups, and tweezers. The materials used in this study were Red Star variety cayenne pepper, 18 kg of manure, and organic materials with doses of 100 ml/L, 150 ml/L, 200 ml/L. Biuret, NHCL and KoH.

2.3. Experimental Design

The design used in this experiment was a 3 × 4 Factorial Randomized Block Design (RAK) with 3 replications, so that it had 12 treatment combinations consisting of two treatment factors: The first factor is FMA (F) which consists of 2 levels: Control , Glomus Moseae , Gigasspora The second factor is the Organic Material Dosage of 4 levels: control , 100 ml/L , 150 ml/L , 200 ml/L.

2.4. Making Organic Material from Red Onion Skin Waste

The manufacture of liquid organic fertilizer from shallot skin waste begins with the collection of shallot skin waste. In 100 g of shallots, 10 g of skin is produced. The shallot skin is weighed as much as 1000 g. EM4 100 ml. after all the ingredients are ready, put them in a 50-liter jerry can and stir using a stirring stick. After mixing well, the jerry can is closed tightly using its lid. Fermentation for 2 weeks. After 2 weeks of fermentation, the organic material from the shallot skin waste changes and is marked by changes in color and structure of the shallot skin. Then, the shallot skin waste can be applied to plants.

2.5. Research Implementation

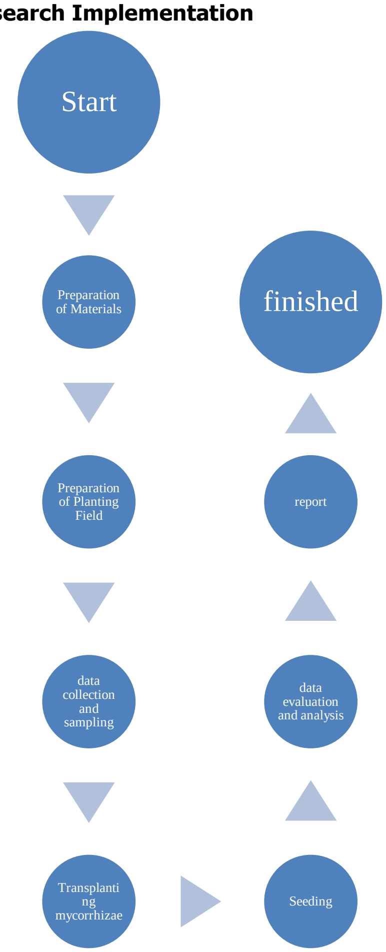

Figure 1. Research flow diagram

2.5.1. Preparation of Seeding Media

The cayenne pepper seedlings planted can be planted directly in polybags. Start by preparing the planting medium first, which consists of a mixture of soil, manure, and compost with a ratio of 1:1:1. After that, put the planting medium into the polybag until it is full. Moving cayenne pepper seedlings from the nursery to the polybag can be done after the seedlings are about 3-4 weeks old. The seedlings have a strong root system and higher resistance at this age range. The transfer process should be done in the afternoon when the low air temperature will reduce the evaporation rate in cayenne pepper seedlings.

2.5.2. Seed Sowing

The planting material used in this study was Red Star variety cayenne pepper. Organic materials were given according to the treatment dose (100 ml/L, 150 ml/L, 200 ml/L) 7 days after transplanting by spraying using a hand sprayer, and each plant was sprayed 5 times. Good seeds were selected for sowing and put into polybags. The nursery was conducted for 4 weeks and maintained with good treatment to avoid disease.

2.5.3. Preparation of Planting Media

Preparation of planting media along with the nursery, the soil used as planting media is topsoil. Before the soil is put into the polybag, the polybag is marked for the soil filling limit. Then the soil is put into a 10 kg polybag.

2.5.4. Labeling

Labeling is given on the front of the polybag. The label is laminated first to prevent damage to the label due to water. Labeling is used to distinguish each treatment given to each plant.

2.5.5. Application of Organic Materials to Cayenne Pepper Plants

Organic Material is given every 7 days by spraying the plants with a dose (100 ml/L, 150 ml/L, 200 ml/L). After the seedlings are 4 weeks old, the seedlings that grow healthily are transplanted to beds. The plants are planted at a distance of 60 cm, and watered daily.

2.5.6. Application of FMA on Cayenne Pepper Plants

The administration of FMA with a dose of 10 grams/plant in all FMA treatments. Cayenne pepper seeds are planted by soaking them in warm water until they germinate, then transferred to seedling polybags.

2.5.7. Plant Maintenance

Plant maintenance includes watering, replanting, weeding and controlling plant pests. The watering process is done twice daily, namely in the morning and evening. Replanting is carried out if there are plants that do not grow or die.

2.5.8. Harvesting

Harvesting is done at the age of 90, 95, 100, 105, and 110 days after planting and is marked by red or yellow fruit. Harvesting is done by picking the fruit along with its stalk.

2.6. Observation Variables

2.6.1. Plant Height (cm)

Plant height was measured every 15, 30 and 45 days from the base to the tip of the highest leaf. Observations were made on sample plants in each bed. Plant height measurements were made using a meter, and then the results of the sample plant measurements were averaged in an observation Table.

2.6.2. Stem Diameter (cm)

Stem diameter measurements were carried out every 15, 30, and 45 days using a caliper measuring from the stem's base to the leaf's tip.

2.6.3. Number of Leaves Per Plant (leaf)

The number of leaves is counted when the plants are 15, 30 and 45 days after planting, with measurements carried out by counting the number of leaves on each chilli plant stem.

2.6.4. Number of Fruits Per Plant (pieces)

Observations were carried out during the harvest, starting from the first harvest onwards, by counting the number of old and red chillies.

2.6.5. Fruit Weight Per Plant (g)

Fruit weighing is carried out at harvest time by weighing all the fruit harvested from one plant.

2.6.6. Wet Weight of Shoots Per Plant (g)

Observation of the wet weight of the plant 110 days after planting: the plant was dismantled and then cleaned with water on the roots, aired for a while and then the weight of the plant was measured using an analytical scale.

2.6.7. Percentage of roots infected with mycorrhiza (%)

After 45 days after planting, the percentage of roots infected with mycorrhiza was observed using a microscope with 10 samples in each observation.

2.7. Data Analysis

Data analysis was done using the Microsoft Office Excel Professional Plus 2019 application, and manual data collection was done.

3. Results and Discussion

3.1. The Effect of AMF Application on the Growth and Yield of Chili Plants

The results of this study indicate that mycorrhiza did not significantly affect plant height at 15, 30 and 45 HST, stem diameter at 15, 30 and 45 HST, number of leaves at 15, 30 and 45 HST, number of leaves at 15, 30 and 45 HST, number of fruits at 110 HST, fruit weight at 110 HST, wet stem weight at 110 HST and root infection at 110 HST.

3.1.1. Plant Height (cm)

The results showed that mycorrhiza did not significantly affect plant height at 15, 30 and 45 HST. The average plant height at 15, 30 and 45 HST in various mycorrhiza treatments can be seen in Table 2.

Table 1. Average plant height at 15, 30 and 45 HST for various types of Mycorrhiza.

Mycorrhizal type (10g/plant)	Plant height (cm)		
	15 HST	30 HST	45 HST
Control	4.58 ± 0.56	15.75 ± 0.76	28.33 ± 1.21
Glomus	6.50 ± 0.56	13.75 ± 0.76	28.25 ± 1.21
Gigaspora	5.83 ± 0.56	16.25 ± 0.76	31.92 ± 1.21

Table 1 shows that at the age of 15 HST the highest value was found in the Glamus treatment , namely 6.50. At the age of 30 and 45 HST the highest value was found in the Gigaspora treatment , namely 16.25 and 31.92 which were not significantly different from all other treatments. This is also in line with the study of the Effect of Mycorrhiza, (Maulana et al., 2022) reported that Glomus moseae increased stem diameter and number of leaves, while Gigasospora was more dominant at the advanced growth stage. In this study, the application of mycorrhiza did not show an effect on the growth of cayenne pepper plants, but showed a certain tendency that can be considered for further research. This indicates similarities in mycorrhiza's potential to increase plant growth, but the results vary depending on the specific conditions and types of plants used.

3.1.2. Stem Diameter (cm)

The results of this study indicate that mycorrhiza did not significantly affect the stem diameter at the ages of 15, 30 and 45 HST. The average stem diameter at the ages of 15, 30, 45 HST in various treatments of mycorrhiza types can be seen in Table 2.

Table 2. Average stem diameter per plant aged 15, 30 and 45 HST in various types of Mycorrhiza.

Mycorrhizal type (10g/plant)	Stem diameter per plant (cm)		
	15 HST	30 HST	45 HST
Control	0.11 ± 0.0033	0.48 ± 0.0371	0.86 ± 0.0379
Glomus	0.10 ± 0.0033	0.38 ± 0.0371	0.73 ± 0.0379
Gigaspora	0.11 ± 0.0033	0.50 ± 0.0371	0.81 ± 0.0379

Table 2 shows that at 15 HST, the highest value was found in the Gigaspora treatment, namely 0.11, which was not significantly different from all treatments. At the age of 30 HST, the highest value was found in the Gigaspora treatment, which was 0.50. At the age of 45 HST, the highest value was found in the control treatment, 0.86, which was not significantly different from all other treatments.

The results of this study indicate that mycorrhizal application did not significantly affect various growth parameters and yields of cayenne pepper plants, such as plant height, stem diameter, number of leaves, number of fruits, fruit weight, wet stem weight, and root infection at the specified observation ages (15, 30, 45, 76, and 103 DAP). This is thought to be due to several factors that affect the effectiveness of mycorrhizal, including environmental conditions such as temperature, humidity, and quality of planting media that can affect mycorrhizal activity in the soil. In addition, the time of application and the physical condition of the plant may also play an important role, so mycorrhizal application does not show significant results.

3.1.3. Number of leaves per plant (leaf)

The results of this study indicate that the type of mycorrhiza did not significantly affect the number of leaves at the age of 15, 30 and 45 HST. The average number of leaves at the age of 15, 30sssss and 45 HST in various treatments of mycorrhiza types can be seen in Table 3.

Table 3 shows that at the age of 15 HST the highest value was found in the Glamus treatment , namely 8.83. At 30 and 45 HST the highest values were found in the control treatment, namely 21.33 and 61.42, which were not significantly different from all other treatments.

Table 3. Average number of leaves at 15, 30 and 45 HST in various mycorrhizal treatments.

Mycorrhizal type (10g/plant)	Number of leaves per plant (leaf)		
	15 HST	30 HST	45 HST
Control	6.92 ± 0.55	21.33 ± 1.53	61.42 ± 3.72
Glomus	8.83 ± 0.55	16.25 ± 1.53	53.08 ± 3.72
Gigaspora	7.92 ± 0.55	17.50 ± 1.53	48.75 ± 3.72

3.1.4. Number of Fruits Per Plant

The results of this study indicate that the type of mycorrhiza did not significantly affect the number of fruits at 110 HST. The average number of fruits at 110 HST in various treatments of mycorrhiza types can be seen in Table 4. Table 4 shows that at 110 HST the highest value was found in the Glamus treatment, namely 1.50, which was not significantly different from all other treatments.

Table 4. The average number of fruits at 110 HST in various mycorrhizal type treatments.

Mycorrhizal type (10 g/plant)	Number of Fruits
Control	1.17 ± 0.099
Glomus	1.50 ± 0.099
Gigaspora	1.42 ± 0.099

3.1.5. Fruit Weight Per Plant (g)

The results of this study indicate that mycorrhiza has no significant effect on fruit weight at 110 HST. The average fruit weight per plant age with various mycorrhiza treatments can be seen in Table 5.

Table 5. Average fruit weight at 110 HST in various mycorrhizal type treatments.

Mycorrhizal type (10 g/plant)	Fruit Weight (g)
Control	118.33 ± 11.25
Glomus	156.25 ± 11.25
Gigaspora	145.08 ± 11.25

Table 5 shows that at 110 HST the highest value was found in the Glamus treatment , namely 156.25, which was not significantly different from all other treatments.

Although not statistically significantly different, several treatments increased in several growth and yield parameters. For example, the Glomus mycorrhizal type tended to increase plant height at 15 DAP and fruit weight, while the Gigaspora type tended to be more effective in increasing plant height at 30 and 45 DAP and root infection at 103 DAP. This indicates the potential benefits of mycorrhizal application, although not significant enough in this study. The study results showed that the application of BPF and FMA, both individually and in combination, increased the growth of cayenne pepper plants. (Rastono & Firgiyanto, 2024)

Several differences and similarities need to be noted. First, in terms of soil conditions, using soil with a pH close to neutral and high salinity, this study was also conducted on soil with high salinity but possibly different pH conditions. The more acidic soil conditions in this study may affect growth parameters, similar to how high salinity in the study affected the growth of chili plants.

3.1.6. Wet Weight of Shoots Per Plant (g)

The results of this study indicate that mycorrhiza does not significantly affect the wet weight of shoots at 110 HST. The average weight of shoots at 110 HST for various types of mycorrhiza can be seen in Table 6.

Table 6. Average wet weight of shoots at 110 HST in various mycorrhizal-type treatments.

Mycorrhizal type (10 g/plant)	Wet Weight of Bundle (g)
Control	134.42 ± 9.62
Glomus	167.42 ± 9.62
Gigaspora	146.92 ± 9.62

Table 6 shows that at 110 HST, the highest value was found in the Glamus treatment, namely 167.42, which was not significantly different from all other treatments. So, in terms of plant response to salinity stress, studies show that high salinity can inhibit plant growth. Salinity stress disrupts the balance of water potential in cells, while in this study, similar conditions caused a decrease in growth parameters. Mycorrhizae in both studies seem to have the potential to help plants cope with this stress, although the results are not always significant.

Overall, although this study did not show the effect of mycorrhizal application on the growth and yield of cayenne pepper plants, there are still potential benefits that require further exploration. Further research with variations in dosage, environmental conditions, or combinations with other cultivation techniques is needed to optimize the use of mycorrhizal in agriculture.

3.1.7. Percentage of Roots Interacting with Mycorrhiza (%)

The results of this study indicate that mycorrhiza has no significant effect on root infection at 45 HST. The average infection at 45 HST in various mycorrhiza-type treatments can be seen in Table 7.

Table 7. Average number of root infections 45 HST in various types of mycorrhiza treatments on cayenne pepper plants.

Types of Mycorrhiza	Root infection per plant 45 HST
Control	53.33 ± 0.96
Glomus	55.00 ± 0.96
Gigaspora	56.67 ± 0.96

Table 7 shows that at age 45, HST had the highest value found in the Gigaspora treatment, namely 56.67, which was not significantly different from all other treatments. This also shows interesting variations. Maulana (2020) found that certain chili varieties, such as Lado and PM 999, showed different growth responses in saline soil. In this study, although the variation of cayenne pepper varieties is not explicitly explained, observations of mycorrhizal types indicate that Glomus and Gigaspora types may have different effects on growth, similar to how chilli varieties show different growth characteristics.

3.2. The Effect of Organic Material on the Growth and Yield of Cayenne Pepper Plants.

The results of this study indicate that Organic Materials do not have a significant effect on plant height at the age of 15.30 and 45 HST, stem diameter at the age of 15.30 and 45 HST, number of leaves at the age of 15.30 and 45 HST, number of fruits at the age of 76 HST, fruit weight at the age of 76 HST, wet stalk weight at the age of 103 HST and have a very significant effect on root infection at the age of 103 HST.

3.2.1. Plant Height

This study showed that the dosage of Organic Materials did not significantly affect the height of plants aged 15, 30 and 45 HST. The average height of plants at 15, 30 and 45 HST in various treatments of Organic Material doses can be seen in Table 8.

Table 8 shows that the height of cayenne pepper plants at the age of 15 the highest value was found in the control (6.67), which was significantly different from the doses of 100,150 and 200 ml/L at the age of 30 and 45 HST; the good dose was at a dose of 150 ml/L compared to the control treatment and doses of 100 and 200 ml/L. The results of this study indicate that Organic Material is still below the control treatment. At the age of 45 HST, a dose of 150 ml/L recorded the highest plant height among the other treatments, although the difference was not statistically significant. This shows that although there are differences in plant height between treatments, the dose of Organic Material does not significantly affect the growth of cayenne pepper plants.

Table 8. Average plant height at 15, 30 and 45 HST at various doses of Organic Material.

Organic Material Dosage	Plant height (cm)		
	15 HST	30 HST	45 HST
Control	6.67 ± 0.62	14.33 ± 0.89	28.56 ± 0.87
Dosage 100 ml/L	4.89 ± 0.62	16.56 ± 0.89	30.67 ± 0.87
Dosage 150 ml/L	4.56 ± 0.62	16.56 ± 0.89	30.89 ± 0.87
Dosage 200 ml/L	6.44 ± 0.62	13.56 ± 0.89	27.89 ± 0.87

3.2.2. Stem Diameter (cm)

The results of this study indicate that the dose of Organic Materials did not significantly affect the stem diameter at the ages of 15, 30 and 45 HST. The average stem diameter at the ages of 15, 30 and 45 HST in various treatments of Organic Material doses can be seen in Table 9.

Table 9. The average stem diameter is 15, 30, and 45 HST at various doses of organic matter.

Organic Material Dosage	Stem Diameter(cm)		
	15 HST	30 HST	45 HST
Control	0.11 ± 0.0033	0.43 ± 0.0321	0.68 ± 0.0486
Dosage 100 ml/L	0.10 ± 0.0033	0.52 ± 0.0321	0.82 ± 0.0486
Dosage 150 ml/L	0.11 ± 0.0033	0.47 ± 0.0321	0.88 ± 0.0486
Dosage 200 ml/L	0.10 ± 0.0033	0.39 ± 0.0321	0.81 ± 0.0486

Table 9 shows that the stem diameter of cayenne pepper at 15 HST is better found at a dose of 150 ml/L (0.11), significantly different from the doses of 100 and 200 ml/L. At 30 and 45 HST, a good dose is found at 150 ml/L compared to the control treatment, with 100 and 200 ml/L doses.

Similarly, stem diameter measurements showed that the dose of Organic Material had no significant effect on the stem diameter of plants at the ages of 15, 30, and 45 HST. The average stem diameter in the control treatment was 0.11 cm at the age of 15 HST, while at doses of 100 ml/L and 150 ml/L, it was recorded at 0.10 cm and 0.11 cm, respectively. At the age of 30, HST, the highest stem diameter, was also found at a dose of 150 ml/L with 0.47 cm, but it was not significant enough to state a significant difference. This reflects that although there is a tendency for growth, the effect of the dose of organic material is not strong enough to produce a significant difference in the stem diameter of cayenne pepper plants.

3.2.3. Number of leaves per plant (sheet)

The results of this study indicate that the dosage of Organic Materials did not significantly affect the number of leaves at the ages of 15.30 and 45 HST. The average number of leaves at the ages of 15.30 and 45 HST in various treatments of Organic Material doses can be seen in Table 10.

Table 10. The average number of leaves at 15, 30 and 45 HST at various doses of Organic Material.

Organic Material Dosage	Number of leaves (blades)		
	15 HST	30 HST	45 HST
Control	8.78 ± 0.60	18.56 ± 0.76	56.22 ± 2.10
Dosage 100 ml/L	6.89 ± 0.60	19.33 ± 0.76	54.44 ± 2.10
Dosage 150 ml/L	7.11 ± 0.60	19.11 ± 0.76	57.67 ± 2.10
Dosage 200 ml/L	8.78 ± 0.60	16.44 ± 0.76	49.33 ± 2.10

Table 10 shows that the number of cayenne pepper leaves at 15 HST tends to be greater at a dose of 150 ml/L. However, at 30 HST, the largest number of leaves was found in the 100 ml/L dose treatment, and at 45 HST, the number of cayenne pepper plant leaves tended to be greater than the control (56.22).

Regarding the number of leaves, this study also showed similar results, where the dose of Organic Material did not significantly affect the number of leaves at the ages of 15, 30, and 45 HST. Although at the age of 15 HST, the highest number of leaves was recorded in the 150 ml/L dose treatment, at 30 HST, the 100 ml/L dose showed the highest number of leaves. Meanwhile, at 45, HST, the highest number of leaves, was found in the control treatment. This indicates that although there are differences in the growth of the number of leaves, the results are not significant enough to conclude that the dose of organic material affects the number of leaves of cayenne pepper plants.

3.2.4. Number of Fruits Per Plant

The results of this study indicate that the dosage of Organic Materials did not significantly affect the number of fruits at 76 HST. The average number of fruits at 76 HST in various treatments of Organic Material dosages can be seen in Table 11.

Table 11. Average Number of Fruit 76 HST at Various Doses of Organic Material.

Organic Material Dosage	Number of Fruits
Control	1.33 ± 0.061
Dosage 100 ml/L	1.44± 0.061
Dosage 150 ml/L	1.44± 0.061
Dosage 200 ml/L	1.22± 0.061

Table 11 shows that the number of fruits per plant tends to be higher in the 150 ml/L dose treatment, and the lowest data is found in the 200 ml/L dose (1.22). In terms of yield, the dosage of organic matter also did not significantly affect the number of fruits at 76 HST. The control treatment recorded an average number of fruits of 1.33, while doses of 100 ml/L and 150 ml/L each recorded 1.44 fruits, and the 200 ml/L dose showed the lowest number with 1.22 fruits. Although the doses of 100 ml/L and 150 ml/L showed a better tendency, the difference was not striking enough. In addition, the weight of the fruit produced at 76 HST showed the same results; the 100 ml/L dose treatment recorded the highest weight with 152.56 g, but not enough to show a significant difference from the other treatments.

On the other hand, research by (Farhan et al., 2018) showed that the use of organic matter did not significantly affect the growth and yield of chili plants, which is similar to the findings in this study. This study examined various doses of organic matter and noted that although there was a slight increase in plant height and fruit number, these differences were not statistically significant. The researchers stated that differences in plant varieties, soil conditions, and environmental factors could be the main reasons for the inconsistent results. They also recommended further research to explore the interaction between organic matter types and plant varieties in different contexts. (Maulana et al., 2024) . Various factors, such as differences in plant varieties, environmental conditions, or the method of application of organic materials used, may cause the difference in results between this study and previous studies. Therefore, it is essential to consider the various factors that affect the results of the study in order to obtain a more comprehensive understanding of the effect of organic materials on the growth and yield of cayenne pepper plants.

3.2.5. Fruit Weight Per Plant (g)

The results of this study indicate that the dosage of Organic Materials did not significantly affect the fruit weight at 76 HST. The average weight of fruit in various treatments of Organic Material doses can be seen in Table 12.

Table 12 shows that the weight of the fruit per plant tends to be heavier in the 100 ml/L dose treatment (152.56), and the lowest data is found in the 200 ml/L dose (127.44). Research by Santoso et al. (2021) shows that applying organic matter also increases the number of fruits and fruit weight in other vegeTable plants, such as tomatoes and chillies. In this study, researchers applied organic matter at various growth phases. They found that using organic matter significantly increased yields, with an increase in the number of fruits reaching 40% in tomato plants. They also noted that plants that received the application of organic matter had better resistance to diseases and pests, which contributed to the improvement in the quality of the fruit produced. These findings emphasize the importance of using organic matter to increase the productivity of vegeTable plants.

Table 12. Average fruit weight 76 HST at various doses of Organic Material.

Organic Material Dosage	Fruit Weight (g)
Control	131.33 ± 7.14
Dosage 100 ml/L	152.56±7.14
Dosage 150 ml/L	148.22±7.14
Dosage 200 ml/L	127.44± 7.14

3.2.6. Wet Weight of Shoots Per Plant (g)

The results of this study indicate that the dosage of Organic Materials did not significantly affect the wet weight of the stalks at the age of 103 HST. The average wet weight of the stalks in various treatments of Organic Material doses can be seen in Table 13.

Table 13. Average wet weight of 103 HST at various doses of Organic Material

Organic Material Dosage	Wet Weight of Bundle (g)
Control	150.67 ± 3.64
Dosage 100 ml/L	140.22±3.64
Dosage 150 ml/L	153.56±3.64
Dosage 200 ml/L	153.44±3.64

Table 13. The wet weight of cayenne pepper plants tends to be heavier in Organic Material with a dose of 150 ml/L (153.56), although statistically, it is not significantly different from the administration of other Organic Material doses. The results of the measurement of wet weight at the age of 103 HST also showed that the dose of organic material had no significant effect, where the average weight at a dose of 150 ml/L was 153.56 g, but did not differ significantly from other treatments. However, it is interesting to note that this study significantly affected the percentage of roots infected with mycorrhiza at the age of 103 HST. The average root infection in the 150 ml/L dose treatment reached 73.33%, higher than the control, which was only 17.78%. This shows that although the dose of organic material does not affect plant growth and yield, it has an essential role in increasing mycorrhizal root infection, which can contribute to overall plant health.

3.2.7. Percentage of Roots Infected with Mycorrhiza (%)

The results of this study indicate that the dose of Organic Material significantly affects root infection at the age of 45 HST. The average root infection at the age of 45 HST in various treatments of Organic Material doses can be seen in Table 14.

Table 14. The average number of root infections is 103 HST in various doses of organic matter treatments on cayenne pepper plants.

Organic Material Dosage	Root infection per plant 45 HST
Control	17.78 ± 14.86 a
Dosage 100 ml/L	57.78 ± 14.86 b
Dosage 150 ml/L	73.33 ± 14.86 c
Dosage 200 ml/L	71.11 ± 14.86 c
BNJ 0.05	5.77

Table 14 shows that the average root infection at 45 HST was better at a dose of 150 ml/L (73.33), although statistically, it was not significantly different from other doses.

When compared to previous studies, several investigations yield different results. Astuti et al. (2020) found that applying organic materials at specific doses can enhance the height of cayenne pepper plants. In their study, the researchers utilized varying doses of organic materials. They discovered that the optimal dose could boost the growth of cayenne pepper plants by up to 30% compared to the control group. Furthermore, this study noted that the routine application of organic materials during the early growth phase significantly influences plant metabolism, resulting in increased photosynthesis and biomass accumulation. The researchers recommend using organic materials as an environmentally friendly alternative to conventional fertilizers to enhance agricultural yields of cayenne pepper.

4. Conclusion

The application of arbuscular mycorrhizal fungi (AMF) did not significantly affect several observed parameters, including plant height, stem diameter, number of leaves, number of fruits, fruit weight, wet stem weight, and the percentage of roots infected with mycorrhiza. The dose of organic material significantly influenced root infection at 45 Days After Planting (HST) but did not significantly impact other parameters. The optimal combination for root interaction at 45 HST was observed with an organic material dose of 150 ml/L. There is a significant interaction between arbuscular mycorrhizal fungi (AMF) and the dosage of organic material on both stem diameter and wet stem weight.

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