

## The effect of chicken and mycorrhizal manure toward cacao seedling growth on ultisol soil

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**Abstract.** Cacao plants are one of the national leading commodities after oil palm and rubber. This study aims to measure the effect of chicken and mycorrhizal manure on cacao seedling growth on ultisol soil. The method used in this study was a randomized block design consisting of two treatment factors. The given of ultisol Soil + Chicken manure (P) consisting of 4 levels: P0 about 100% (control), P1 about 25% Chicken manure + 75% ultisol, P2 about 50% Chicken manure + 50% ultisol and P3 about 75% Chicken manure + 25% ultisol. Administration of Mycorrhizal Dosage: M0 about 0 g Mycorrhiza (control), M1 about 25 g Mycorrhiza, M2 about 50 g Mycorrhiza and M3 about 75 g Mycorrhiza. Based on the results of the study, it can be stated that chicken manure treatment up to 75% and increased plant growth, number of leaves, leaf area, wet weight of seed, root volume and dry weight of seedlings, but not to the diameter of cacao seed stems. The treatment of mycorrhizal doses of up to 75 g/plant and increased plant growth, number of leaves, leaf area, wet weight of seed, root volume and dry weight of seedlings, but not to the diameter of cacao seedling stems. The interaction of chicken manure and mycorrhizal doses had no significant effect on all parameters.

**Keywords:** chicken manure, mycorrhizae, cacao, ultisol

### 1. Introduction

The cacao nurseries was influenced by planting media that reaches the requirements such as topsoil which is already in a limited amount, thus soil is needed with various modifications to be suitable for nursery media. However, the use of ultisol soil types is constrained by low nutrient fertility levels that can inhibit the growth and development of cacao seedlings [1-6]. One of the natural soil enhancers that can be used is chicken manure. Chicken manure is often used because chicken manure has the high value in increasing yield, easily obtained and higher in price.

Chicken manure is different from other types of manure, since it is more mature. Chicken manure in addition for adding nutrients to the soil can also improve soil structure and encouraged the life of soil microorganisms [7-12]. In an effort to increase land productivity can be done with the application of mycorrhiza. Mycorrhiza is a form of mutual association between fungi and rooting of high plants. Mycorrhizal fungi and roots live in mutual symbiosis, giving benefits for each other.

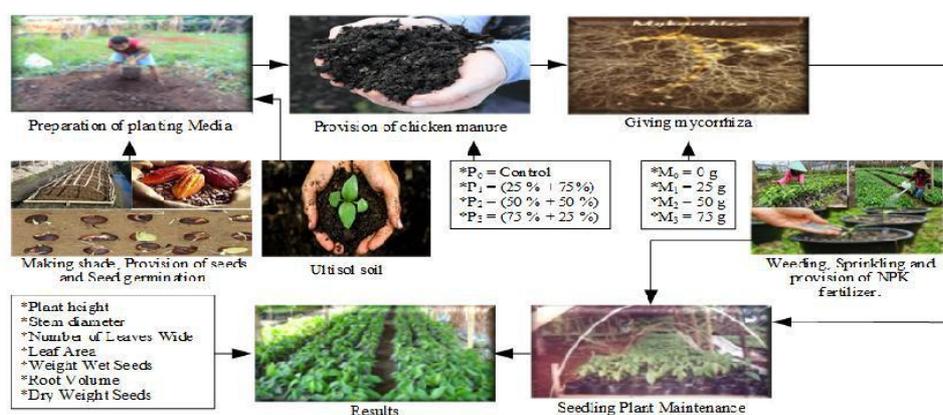
Fungi obtained carbon supply and energy from the roots and then fungi helped the roots in the absorption of nutrients for plants, especially nutrients that were small in the soil, not like P, and increased water uptake and drought resistance. There were several factors that influence the development of Arbuscular Mycorrhizal Fungi (AMF). The effectiveness of each type of Arbuscular



Mycorrhizal Fungi (AMF) was influenced by the type of plant and soil. In addition, the activity and development of mycorrhizal fungi was influenced by the level of phosphate fertilization, so that in this study, the authors wanted to see the effect of applying chicken manure and mycorrhizal manure toward the cacao seedling growth on ultisol soil [13-22].

## 2. Research Methods

The material used in this study was criolo types of cacao fruit from the Cacao Garden, Pancur Batu Village, while the ultisol soil, chicken manure, mycorrhizae, NPK Mutiara fertilizer, and Polydor insecticide from Tanjung Anom village. The tools used in this study were hoes, analytic scales, meters, porous envelopes, measuring cups, knives, calipers, hammer, sitting scales, stationery, rulers, buckets, broach, polybags with a size of 15 cm x 15 cm with a capacity of 2, 5 kg, and sprayer. The research was carried out on making chicken and mycorrhizal manure on the growth of cacao seedlings on ultisol soil, as shown in **Figure 1**. As shown:



**Figure 1.** Flowchart of research

## 3. Results and discussion

Based on the results of the study, it was found that the treatment of chicken manure had no significant effect on the height of cacao seedlings at the age of 1, 3 and 5 MST, but significantly affected at the ages of 5, 7 and 9 MST. Treatment of mycorrhizal doses significantly affected plant height at all ages of observation. The interaction between the two treatments had no significant effect on plant height at all ages of observation. The average height of cacao seedlings that was influenced by chicken manure and mycorrhizal doses at the ages of 1, 3, 5, 7, 9 and 11 MST from the results showed that the treatment of chicken manure, and the interaction between the two treatments had no significant effect on stem diameter at all ages of observation.

Treatment of mycorrhizal doses significantly affected the stem diameter at all ages of observation. The average diameter of cacao seedling stems that was caused by chicken manure and mycorrhizal doses effects at the ages of 1, 3, 5, 7, 9 and 11 MST. The treatment of chicken manure had no significant effect on the number of leaves at the age of 1, 3, 5, 7 and 9 MST, but had a significant effect at the age of 11 MST. The treatment of chicken manure and mycorrhizal doses significantly affected the wet weight of cacao seedlings, while the interaction between the two treatments did not significantly affect the weight of cacao seeds. The treatment of mycorrhizal doses significantly affected the number of plant leaves at all ages of observation. The treatment of chicken manure significantly affected the leaf area, while the treatment of mycorrhizal doses and the interaction between the two treatments had no significant effect on the leaf area of cacao seedlings. From the results, it showed that the treatment of chicken manure and mycorrhizal dose significantly affected the root volume of cacao seedlings, while the interaction between the two treatments had no

significant effect on the root volume of cacao seedlings. The interaction between the two treatments had no significant effect on the number of plant leaves at all ages of observation, plant height, stem diameter, and number of cacao seed leaves of the treatment of chicken manure and mycorrhizal as shown in **Table 1** below.

**Table 1.** Plant height, stem diameter, and number of cacao seed leaves of the treatment of chicken manure and mycorrhizal doses at age 1, 3, 5, 7, 9 and 11 MST

Parameter	Treatment	Age of Observation					
		1 MST	3 MST	5 MST	7 MST	9 MST	11 MST
Plant Height	P <sub>0</sub>	47.17	53.66	61.08	70.87a	81.86a	97.73a
	P <sub>1</sub>	47.92	53.53	61.6	71.48ab	82.41a	99.52ab
	P <sub>2</sub>	48.17	53.72	62.54	71.93ab	82.30a	100.18ab
	P <sub>3</sub>	50.63	56.5	63.78	75.02b	88.58b	104.35b
	BNJ	-	-	-	3.71	5.16	5.89
	M <sub>0</sub>	45.21a	50.92a	57.59a	67.24a	77.06a	91.26a
	M <sub>1</sub>	47.42ab	52.84a	60.66ab	70.48ab	82.16a	97.49b
	M <sub>2</sub>	49.83b	54.78a	63.02b	73.58b	84.97ab	101.62b
	M <sub>3</sub>	51.42b	58.87b	67.74c	78.00c	90.97c	111.42c
	BNJ	4.00	3.90	3.25	3.71	5.16	5.89
Stem Diameter	P <sub>0</sub>	1.11	1.36	1.53	1.63	1.74	2.14
	P <sub>1</sub>	1.06	1.43	1.58	1.68	1.78	2.17
	P <sub>2</sub>	1.09	1.4	1.55	1.68	1.76	2.15
	P <sub>3</sub>	1.08	1.41	1.54	1.68	1.8	2.23
	BNJ	-	-	-	-	-	-
	M <sub>0</sub>	1.00a	1.31a	1.45a	1.56a	1.68a	2.05a
	M <sub>1</sub>	1.06ab	1.39b	1.53ab	1.67b	1.74ab	2.14ab
	M <sub>2</sub>	1.13bc	1.43bc	1.57bc	1.68bc	1.79bc	2.20bc
	M <sub>3</sub>	1.16c	1.46c	1.64c	1.78c	1.87c	2.29c
	BNJ	0.07	0.07	0.10	0.10	0.08	0.14
Number of Leaves	P <sub>0</sub>	12.33	17.5	25.83	33.33	36.75	56.25a
	P <sub>1</sub>	11.08	18.58	26.5	33.5	39.08	58.58ab
	P <sub>2</sub>	12	17.92	25.92	34	37.25	60.00ab
	P <sub>3</sub>	11.5	18.67	26.42	34.92	40.08	64.08b
	BNJ	-	-	-	-	-	5.96
	M <sub>0</sub>	10.33a	15.83a	23.42a	29.50a	33.42a	50.50a
	M <sub>1</sub>	11.58ab	17.33b	25.08ab	32.83ab	35.92a	55.92ab
	M <sub>2</sub>	12.08bc	19.08c	26.83b	35.00bc	39.83b	61.33b
	M <sub>3</sub>	12.92c	20.42d	29.33c	38.42c	44.00c	71.17c
	BNJ	1.27	1.30	2.43	4.10	3.52	5.96

Description: The number followed by the same letter in the same column means no different at the 5% test level.

The average root volume of cacao seedlings that was caused by the chicken manure and mycorrhizal doses effects. Based on the results of the study, it was found that the treatment of chicken manure and mycorrhizal doses significantly affected the weight of cacao seedlings, while the interaction between the two treatments had no significant effect on the weight of cacao seedlings. The average weight of cacao seedlings that was caused by the chicken manure and mycorrhizal doses effects can be seen in **Table 2**.

**Table 2.** Mean of Leaf Area, Weight of Seed, Root Volume and Weight Cacao Seeds that was caused

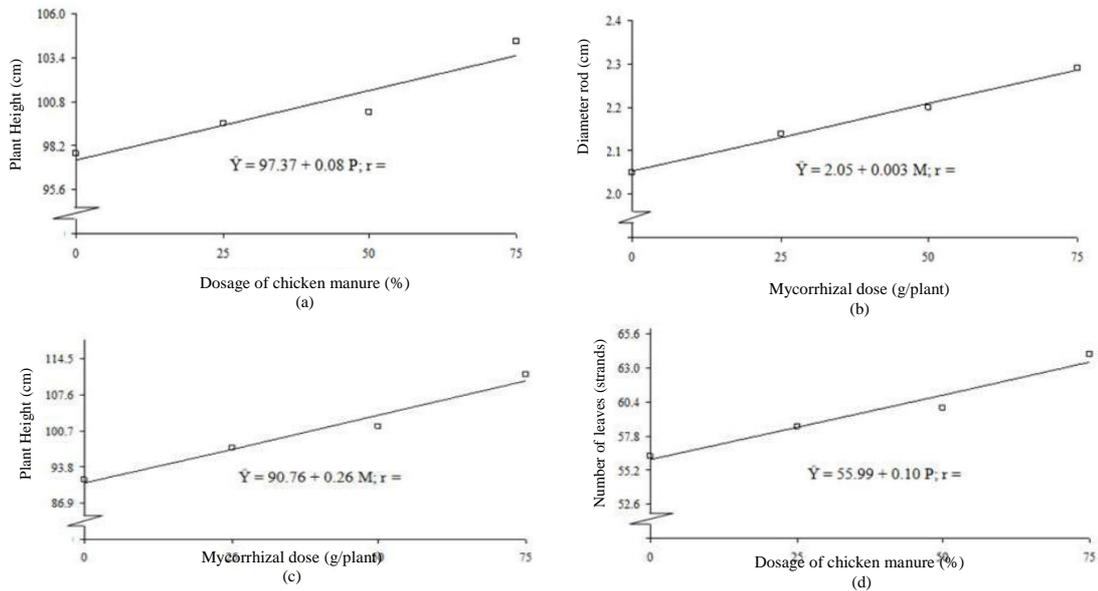
by the chicken manure and mycorrhizal doses effects

Parameter	Treatment	M <sub>0</sub>	M <sub>1</sub>	M <sub>2</sub>	M <sub>3</sub>	Average
Leaf Area	P <sub>0</sub>	245.75	285.12	300.17	305.06	284.03a
	P <sub>1</sub>	252.57	311.56	297.2	318.24	294.89ab
	P <sub>2</sub>	285.58	281.94	298.82	354.48	305.21ab
	P <sub>3</sub>	317.33	368.13	340.42	375.33	350.30b
	Average	275.31	311.69	309.15	338.28	-
Weight Seeds	P <sub>0</sub>	46	53.33	56.67	60.67	54.17a
	P <sub>1</sub>	47.33	52.33	56	62.33	54.50ab
	P <sub>2</sub>	51	57	60.67	70.67	59.83ab
	P <sub>3</sub>	47.67	55.67	65.67	74.33	60.83b
	Average	48.00a	54.58ab	59.75bc	67.00c	-
Root Volume	P <sub>0</sub>	7.67	9.67	10	9.67	9.25a
	P <sub>1</sub>	7.33	8.67	10.33	10	9.08a
	P <sub>2</sub>	7.33	8.67	10	10.67	9.17a
	P <sub>3</sub>	8.33	10.67	11.67	12	10.67b
	Average	7.67a	9.42b	10.50c	10.58c	-
Dry Weight Seeds	P <sub>0</sub>	31.67	35	37.67	39.33	35.92a
	P <sub>1</sub>	33	37.67	37.33	40.67	37.17a
	P <sub>2</sub>	33.33	34.67	37	39.33	36.08a
	P <sub>3</sub>	35.33	42.33	44.67	45	41.83b
	Average	33.33a	37.42b	39.17bc	41.08c	-

Description: The number followed by the same letter in the same column means no different at the 5% test level.

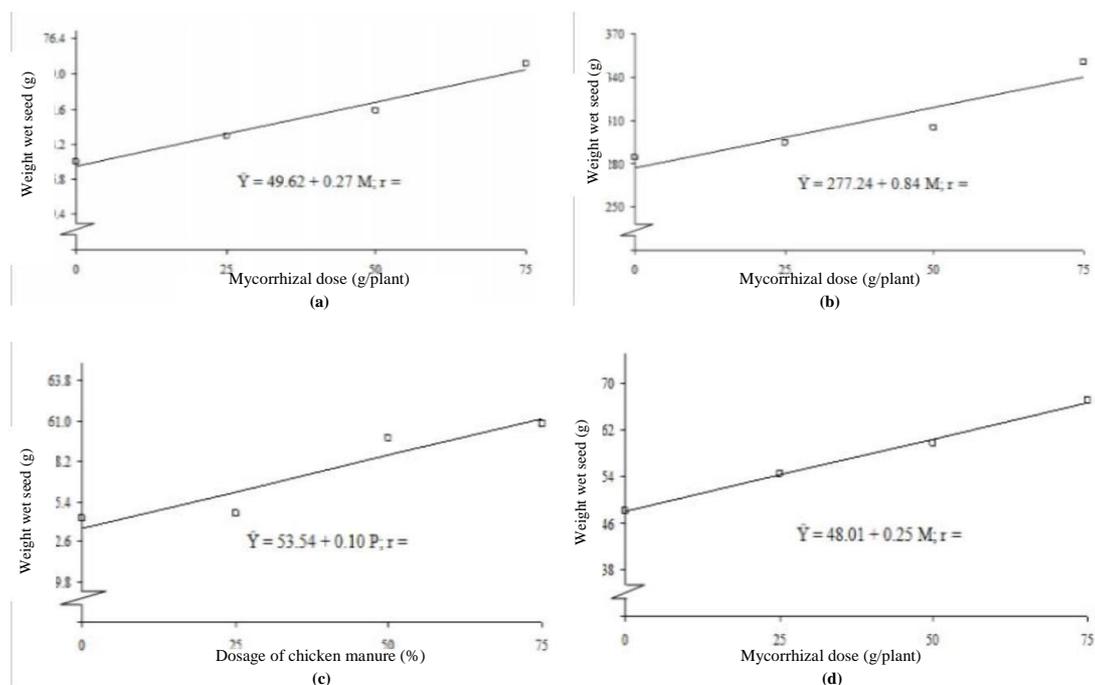
The higher of chicken manure doses, the higher of the plant height. It was because chicken manure can contribute organic matter which can affect the physical, chemical and biological properties of the soil. Physical properties of soil, organic matter can affect the texture, water holding capacity, moisture, and the availability of soil nutrients. Therefore, the soil that was given organic materials such as chicken manure, will be able to bind water and nutrients, and can easily be used by plants. Since the effects of mycorrhiza fungi that can be increased absorption of nutrients by the external mycelium by expanding the surface of root absorption or through the results of chemical compounds that cause the release of nutrient bonds in the soil.

According to an expert [23], stated that extra radical mycelium in the soil found around the roots produces material that promotes soil aggregation can improve aeration, water absorption, and soil stability. Increasing organic matter due to increasing doses of manure can improve soil physical properties, where soil texture becomes looser. So that, nutrient was availability and there was microbial activity. It will push the growth of plant roots, so that it will increase nutrient uptake by plants used in photosynthesis. The photosynthate produced will be used in the formation of new plant organs. **Figure 2.** showed that the higher of chicken manure doses, the higher of the number of plant leaves.



**Figure 2.**(a) the relationship of poultry fertilizer with cacao planting at 11 months after planting  
 (b) dosage of mycorrhizalism with plant cacao height at age of 11 weeks after planting  
 (c) dosage of mycorrhizal doses with seedling stems cacao at 11 weeks after planting  
 (d) relationship of poultry fertilizer with number of leaves of cacao seed plant at age 11 weeks after planting.

The higher of mycorrhizae doses, the number of plant leaves will increase. The given of mycorrhiza will improve the physical and biological properties of the soil, where the soil becomes looser. It will increase the absorption of water or nutrients by plants and the metabolism of carbohydrates, proteins and growth regulating substances, and vitamins which can push plant growth. The higher of chicken manure doses, the greater the leaf area of the plant. The given of chicken manure can improve the consistency of the soil to become loose and more crumbly, so that the growth of plant roots becomes better [24]. Besides that, chicken manure contributed elements of nitrogen that can be used by plants in photosynthesis. The increasing rate of photosynthesis in plants will increase the formation of new organs of plants including the increase in plant leaf area. The higher of chicken manure doses, the higher of cacao seedlings weight. Through the given of chicken manure, the availability of nutrients during plant growth was increasing. Elements of N, P and K were needed in the process of forming plant tissues. When nutrient supply was available more, the plant organs that were formed will increase, so that the wet weight of the seed will also increase. Plants that infected with mycorrhizae had a higher wet weight of plants where phosphorus concentrations at the top and roots of plants had a high value compared with no mycorrhizae. **Figure 3.** showed that the higher of the mycorrhizal dose, the higher of the wet weight of cacao seedlings. It was caused by the increasing supply of phosphorus by microzia.



**Figure 3.** (a) dosage of mycorrhizal relations with the number of leaves of cacao seeds at age 11 weeks after planting, (b) relationship of poultry cage with leaf area of cacao seed plantation, (c) relationship of chicken poultry manure with weight of cacao seeds, (d) mycorrhiza dosage relationship with wet weight of cacao seeds.

The use of manure as a mixture of planting media on ultisol soil would increase the growth of cacao seedlings. It was caused by the given of manure that could improve the physical properties of the planting medium which consisted of ultisol soil of nutrient-poor soil. The addition of manure would improve the physical and chemical properties of the soil. The increasing of organic that was caused by the addition of chicken manure, had been effected the growing media to become looser with increasing microbial and water content. Thus, the plant root growth was better, where soil can absorb water and nutrients in greater amounts. According to an expert [25], stated that chicken manure contains 55.00% H<sub>2</sub>O; 1.00% N; 0.80% P<sub>2</sub>O<sub>5</sub>, and 0.40% K<sub>2</sub>O. In addition, chicken manure contained of calcium and magnesium nutrients, as well as several micro nutrients such as copper, manganese, and barium. All these elements were needed for plant growth and development [26].

The results showed that the given of mycorrhizae up to 75 g/plant on the planting medium with ultisol soil could increase plant height. The given of mycorrhizae would improve the physical and biological properties of ultisol soil, where the soil becomes looser. It would increase the absorption of water or nutrients by plants, and also would increase the metabolism of carbohydrates, proteins and growth regulating substances, and vitamins that can push plant growth. It was supported by the opinion [27], stated that most of the plant growth inoculated with mycorrhizal fungi showed a positive relationship, namely increasing the growth of plants. It could occur since the infection of mycorrhizal fungi which can increase the absorption of nutrients by the external mycelium by expanding the

surface of root absorption or through the results of chemical compounds that cause the release of nutrient bonds in the soil. [23] An expert reported that extra radical mycelium in the soil around the roots produced material that pushed soil aggregation, so it could improve aeration, water absorption and soil stability. The results showed that the interaction of chicken manure and mycorrhizal dose had no significant effect on all parameters observed. It was caused by the fact at the beginning growth of chicken manure and mycorrhizal fertilizers that had a greater role in improving the physical properties of the soil. Chicken manure was a fertilizer that needs much time to process, where the decomposition process is needed first, before it can be used by plants, while mycorrhizae contribute to plant growth faster. This led to unrealistic interactions between the two groups in supporting the growth of cacao seedlings. To determine the correlation between the parameters observed can be seen in **Table 3**.

**Table 3.** Interview Correlation Observed

Parameter	TT	DB	JD	LD	BBB	VA	BKB
TT	1						
DB	0.89*	1					
JD	0.90*	0.90*	1				
LD	0.79*	0.71*	0.73*	1			
BBB	0.90*	0.91*	0.95*	0.75*	1		
VA	0.81*	0.88*	0.82*	0.80*	0.85*	1	
BKB	0.85*	0.81*	0.85*	0.89*	0.81*	0.91*	1

Information :

r<sub>0.05</sub> = 0.58

\* = real

TT = Plant Height

DB = Stem diameter

JD = Total Leaf

LD = Leaf Area

BBB = Weight Wet Seed

VA = Root Volume

BKB = Dry Weight Seeds

In **Table 3**, it can be seen that plant height was significantly correlated with stem diameter, number of leaves, leaf area, wet weight of seed, root volume, and dry weight of seed. It means that the higher the plant, would be followed by an increase in stem diameter, leaf number, leaf area, wet weight of seed, root volume, and dry weight of the seedlings. Stem diameter had a significantly positive correlation with the number of leaves, leaf area, wet weight of seed, root volume, and dry weight of the seedlings. The number of leaves had a significantly positive correlation with leaf area, wet weight, root volume, and dry weight seed. Leaf area had a significantly positive correlation with wet weight of seed, root volume, and dry weight of seedlings. The wet weight of seed was significantly positively correlated with root volume, and dry weight of seed. Root volume correlated significantly positively with the dry weight of seed.

#### 4. Conclusion

The treatment of chicken manure up to 75%, and it was plant height, number of leaves, leaf area, wet weight of seed, root volume, and dry weight of the seedlings, but not significantly on the diameter of the cacao seedling stems. Treatment of mycorrhizal doses of up to 75 g / plant and it increased plant height, number of leaves, leaf area, wet weight of seed, root volume, and dry weight of seedlings, but not significant to the diameter of cacao seedling stems. The interaction of chicken manure and mycorrhizal doses had no significant effect on all parameters.

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