SEEDLING GROWTH IN RESPONSE TO COCOA (*Theobroma cacao* L.) FOR THE PROVISION OF GUANO FERTILIZER AND MYCORRHIZAL ORGANIC FERTILIZER IN THE NURSERY

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ABSTRACT

This study aimed to evaluate the response of guano fertilizer and mycorrhizal organic fertilizer on plant growth cocoa *(Theobroma cacao L.)* in nursery. The research was conducted dilahan trial University of Muhammadiyah Sumatra Utara, Tuar Street, Medan Amplas District, with a height of ± 25 meters above sea level. The research was conducted on 7 November 2014 untill 12 January 2015. This study used a Randomized Block Design factorial with 2 factors studied, that is guano fertilizer is divided to four levels ie G0 = Without Giving, G1 = 30 g / plant, G2 = 60 g / plant, G3 = 90 g / plant and mycorrhizal organic fertilizers is divided to four levels ie M0 = 3 g / plant, M2 = 6 g / plant and M3 = 9 g / plant. Guano fertilizer as the first factor, and biofertilizers mycorrhizae as a second factor, which the parameters measured were plant height, number of leaves, stem diameter, leaf area, fresh weight of cocoa seeds, cocoa seedling dry weight. The results showed that treatment of guano fertilizer and mycorrhizal biofertilizers showed a marked influence on the parameters of seedling height, stem diameter, wet weight of seed and seedling dry weight as well as providing the best growth response is treatment with high guano fertilizer plant G3 (24.56 cm) , seedling wet weight G3 (14.14 grams), a biological fertilizer mycorrhizal seedling height parameter with the highest value M3 (24.72 cm) diameter rod M3 (0.53 cm), M3 wet weight (14.97 grams), dry weight M3 (10.67 grams).

Keywords: Guano, Mycorrhiza, Cocoa(*Theobroma cacao* L

A. INTRODUCTION

Cocoa plants (*Theobroma cacao* L.) is one of Indonesia's leading commodities, both to meet domestic needs and export needs, and has a fairly bright prospect in the globalization era of free market competition, which aims to increase the country's foreign exchange earnings. Thus the expansion of cocoa plants needs to be continuously improved. Cocoa plants come from tropical forests of Central America and in northern South America. The development of cocoa in Indonesia can be seen in terms of planted area and its contribution to the country as an export commodity. Until 2006, the cocoa plantation area was 1.19 million ha, with a composition of 92.8% being smallholder plantations with an average growth of 7.4% per year (Siregar, *et al*., 2010).

Good cocoa seedlings are the basic capital for farmers to benefit from cocoa farming. Cocoa is an economical annual crop until the age of 37 years, so mistakes in choosing seeds will cause long-term losses. Therefore seed selection is a very important first step in cocoa cultivation (Agriculture Research and Development Agency, 2008).

In order to support the successful expansion of cocoa development, it is necessary to pay attention to climate and soil factors, thus rainfall, temperature, sunlight, humidity, type, structure, soil texture whose physical chemical and biological properties must be fertile and gambur, top soil) and also organic matter which is a very important factor for growth and production of cocoa plants which are determined by the initial growth of plants. One of the influencing factors is in the form of plant media and fertilizer used (Anonym, 2013).

Mycorrhiza is a root system structure which is included as a manifestation of mutualism symbiosis between fungi (Mices) and roots (Rhiza) of tall plants, has a very broad spectrum both in terms of host plants, types of fungi, association mechanisms, effectiveness, mikrohabitat and its spread. In this phenomenon the fungus infects and colonizes the roots without causing necrosis as is common in pathogenic fungal infections, and obtains a regular supply of nutrients from plants. In this case the fungus does not damage or kill the host plant but gives an advantage to the host plant where the host plants receive mineral nutrients, while the fungus receives carbon compounds from the photosynthesis of the host plant (Nurhayati, 2012).

Guano is a fertilizer that originates from sediments of seabirds found in caves or dirt from many bats found in the forest, which are piled up or deposited for a long time. In principle, guano fertilizer is the same as organic fertilizer, only it has a better (excess) content for elements N, P and K than ordinary organic fertilizers. Excess P content is generally caused by bat droppings (guano) which are buried in caves where rocks and water droplets contain a high enough phosphate (P) content. While the advantages of N and K due to food factors are eaten by bats. Guano fertilizer contains macro nutrients of 7.5% nitrogen (N), 8.1% phosphorus (P) and 2.7% kalium (K) (Samijan, 2010).

B. MATERIALS AND METHOD

This research was conducted at the experimental site University of Muhammadiyah Sumatra Utara,TuarStreet, Medan Amplas District, with altitude of ± 25 meters above sea level. This research was conducted on 7 November 2014 until 12 January 2015.

The materials used in this study were 858 TSH cocoa seeds, bamboo, paranet, polybags (18 x 25), sand, top soil soil, water, mycorrhizal biofertilizer, guano fertilizer, decisive 25 EC insecticide, and dithane M-45 fungicide.

The tools used in the study were tripe machetes, hoes, rakes, hooves, saws, machetes, stationery, calculators, analytical scales, signposts, schalifers, handsprayers, and wires.

This research was conducted using Factorial Randomized Block Design with two factors examined as follows:

1. Factor of guano fertilizer (G) with 4 levels, namely: G_0 = (control), G_1 = 30 g / plant, G_2 = 60 g / plant, G_3 = 90 g / plant.
2. Factors for giving mycorrhizal biofertilizer (M) with 4 levels, namely: M_0 = (control) M_1 = 30 g / plant, M_2 = 60 g / plant, M_3 = 90 g / plant.

The observed variables included plant height, number of leaves, stem diameter, leaf area, seed wet weight and seed dry weight at age 2 MSPT to 8 MSPT. Data from the results of this study were analyzed by ANOVA and continued witha different mean test according to Duncan's Multiple Range Test (DMRT) at the level of 5%.

C. RESULTS AND DISCUSSION

Result

Plant Height

From the results of data analysis, it was found that the guano fertilizer treatment showed a significant effect on the parameters of seedling age of 8 MSPT and mycorrhizal biofertilizer showed a significant effect on the parameters of cacao seedlings at age 6 and 8 MSPT, while the interaction of the two treatments had no significant effect on parameters plan.

Table 1. Height of Cocoa Seedlings (cm) by Giving Guano and Mycorrhizal Organic Fertilizer 8 MST

Guano Fertilizer	Mycorrhizal Organic Fertilizer				Average
	M_0	M_1	M_2	M_3	
G_0	20,77	22,43	23,73	24,67	22,90d
G_1	23,80	22,33	23,47	23,83	23,36bc
G_2	24,33	23,43	22,27	24,40	23,61b
G_3	22,87	24,67	24,73	25,97	24,56a
Average	22,94c	23,22ab	23,55ab	24,72a	

Information: Numbers followed by letters that are not the same in the same column and row are significantly different at the level of 5% according to DMRT

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Based on Table 1 it can be seen that the height of cacao seedlings with guano fertilizer treatment at the age of 8 MST was highest in treatment G3 (90 g/plant) with 24.56 cm which was significantly different from treatment G_0 (control) 22.90 cm, G_1 (30 g/plant) 23.36 and G_2 (60 g/plant) 23.61 but treatment G_1 (30 g/plant) 23.36 and G_2 (60 g/plant) 23.61. The highest mycorrhizal biofertilizer at the age of 8 MST was found in the treatment of M3 (9 g/plant) with 24.72 cm which was significantly different from the treatment of M_0 (control) 22.94 cm, M_1 (3 g/plant) 23.22 cm and M_2 (6 g/plant) 23.55 cm but treatment M_0(control) 22.94 cm, M_1 (3 g/plant) 23.22 cm and M_2 (6 g/plant) 23.55 cm.

Leaves Number

The results of the analysis showed that the guano fertilizer treatment and the administration of mycorrhizal biofertilizers along with the interactions of the two treatments showed insignificant results on the number of leaves of cacao seedlings.

Leaves Area

The results of the analysis showed that the guano fertilizer treatment and the administration of mycorrhizal biofertilizers along with the interactions of the two treatments showed insignificant results on the leaf area of the cacao seedlings.

Stems Diameter

Based on observational data and variance results it can be seen that in observations of 2 MST and 4 MST the administration of guano fertilizer and administration of mycorrhizal biofertilizers and their interactions had no significant effect on the stem diameter of cocoa seedlings 4 MST and 6 MST. In observing the stem diameter at 6 MST the administration of guano fertilizer and its interaction had no significant effect, but the administration of mycorrhizal biofertilizer significantly affected the stem diameter of the cacao seeds 6 MST and 8 MST.

Table 2. Stem Diameter of Cocoa Seedlings (cm) 8 MST with Giving Guano and Mycorrhizal Organic Fertilizer Fertilizers.

Guano Fertilizer	Mycorrhizal Organic Fertilizer				Average
	M_0	M_1	M_2	M_3	
G_0	0,49	0,52	0,45	0,52	0,50
G_1	0,49	0,48	0,49	0,52	0,50
G_2	0,47	0,47	0,49	0,52	0,49
G_3	0,48	0,50	0,53	0,55	0,51
Average	0,48c	0,49ab	0,49ab	0,53a	

Information: Numbers followed by letters that are not the same on the same line are significantly different at the level of 5% according to DMRT

Based on Table 2, it can be seen the stem diameter of cacao seedlings with the treatment of mycorrhizal biofertilizer at the age of 8 MST was highest in the treatment of M_3 (9 g/plant) with 0.53 cm which was significantly different from the treatment M_0 (control) 0.48 cm, M_1 (3 g/plant) 0.49 cm and M_2 (6 g/plant) 0.49 cm but treatment M_1 (3 g/plant) and M_2 (6 g/plant) showed results that were not significantly different.

Seeds Wet Weight

Based on observational data and variance results, it can be seen that in observing the wet weight of cocoa seedlings the administration of guano fertilizer and the administration of mycorrhizal biofertilizer showed significant results, whereas for the interactions both showed results that had no significant effect on wet weight.

Table 3. Wet Weight of Cocoa Seedlings (g) by Giving Guano and Mycorrhizal Organic Fertilizer Fertilizers.

Guano Fertilizer	Mycorrhizal Organic Fertilizer				Average
	M_0	M_1	M_2	M_3	
G_0	11,61	11,22	12,31	14,70	12,46cd
G_1	13,14	13,87	12,73	15,37	13,78c
G_2	13,12	14,23	14,20	14,53	14,02b
G_3	13,60	13,37	14,30	15,30	14,14a
Average	12,87d	13,17bc	13,38b	14,97a	

Information: Numbers followed by letters that are not the same in the same column and row are significantly different at the level of 5% according to DMRT

Based on Table 3, it can be seen that the wet weight of the heaviest cocoa seedlings with guano fertilizer is found in treatment G_3 (90 g/plant) which is 14.14 g which is significantly different from treatment G_0 (control) 12.46 g and G_1 (30 g/plant) 13.78 g, but not significantly different from the treatment of G_2 (60 g/plant) 14.02 g. The administration of mycorrhizal biofertilizer had a significant effect on the wet weight of cacao seedlings, where the dose of M_3 (9 g/plant) 14.97 g gave a significantly different result to M_0 (control) 12.87 g, M_1 (3 g/plant) 13.17 g, and M_2 (6 g/plant) 13.38 g.

Seeds Dry Weight

Based on observational data and variance results, it can be seen that the observation of cacao seedling dry weight due to mycorrhizal biofertilizer showed significantly different results, while guano fertilizer and the second interaction between guano fertilizer and mycorrhizal biofertilizer showed results that had no significant effect on seed dry weight.

Table4. Dry Weight of Cocoa Seedlings (g) by Giving Guano and Mycorrhizal Organic Fertilizer Fertilizers.

Guano Fertilizer	Mycorrhizal Organic Fertilizer				Average
	M_0	M_1	M_2	M_3	
G_0	9,78	8,81	10,31	10,61	9,88
G_1	9,70	9,99	10,71	10,68	10,27
G_2	9,35	10,02	10,61	10,75	10,18
G_3	9,65	10,14	10,97	10,62	10,34
Average	9,62cd	9,74c	10,65ab	10,67a	

Information: Numbers followed by letters that are not the same on the same line are significantly different at the level of 5% according to DMRT.

Based on Table 4, it can be seen that the dry weight of the heaviest cocoa seedlings with mycorrhizal biofertilizers was found in the treatment of M_3 (9 g/plant) which was 10.67 g which was significantly different from the treatment M_0 (control) 9.62 g and M_1 (3 g/plants) 9.74 g, but not significantly different from M_2 treatment (6 g/plant) 10.65 g.

Discussion

Effect of Guano Fertilizer Giving on Cocoa Seed Growth

Based on the results of research and variance, it can be seen that the administration of guano fertilizer has significant effect only on plant height 8 MST, and wet weight of seedlings.

In the observation of 8 cacao seedlings the highest Guano fertilizer was found in G3 treatment (90 g/plant), which was as high as 24.56 cm. As it is known that guano fertilizer is an organic fertilizer containing macro and micro nutrients, nutrient requirements for plant growth especially N. nutrient. It is thought that the role of N elements can stimulate the growth of plant height in cocoa seedlings so as to increase plant height especially for high cacao seedlings. Nitrogen is a nutrient needed by plants in large quantities, this is in accordance with Novizan (2002), nitrogen is needed in relatively large quantities at each stage of plant growth, especially at the vegetative growth stage, such as bud formation or stem development.

In observing the wet weight of plants with guano fertilizer, it can be seen that the heaviest mean of treatment G3 (90 g/plant) of 14.14 g is best when compared with other treatments. It is suspected that the wet weight of the cocoa seedlings is influenced by the composition of nutrients derived from guano, because it contains nitrogen, phosphorus, calcium. This is in accordance with Lindawati et al., (2000) which states that guano fertilizer has the role of increasing nutrient availability in the soil and cation exchange capacity, and these nutrients include macro nutrients that can be absorbed by plants to optimize photosynthesis as a producer of assimilation so that they can improve the growth of cocoa plants.

Effect of Mycorrhizal Organic Fertilizer on Cocoa Seed Growth

Based on the results of research and variance, it can be seen that the administration of mycorrhizal biofertilizer significantly affected the height of 6 MST and 8 MST seeds, stem diameter 6 MST and 8 MST, seed wet weight, seed dry weight.

In the administration of mycorrhizal biofertilizer, the observed parameters such as the height of 6 MST and 8 MST seedlings 6 MST and 8 MST, seed wet weight, and seed dry weight showed significantly different results with the best dose given in M_3 (9 g/plant) It is suspected that mycorrhizae can extend and broaden the root reach of nutrient absorption, so that nutrient uptake of plants increases so that metabolic activity takes place well. (Choet et al., 2006) states that mycorrhizae play a role in facilitating nutrient uptake of plants through external hyphae in particular P, Zn, and Cu. Thus mycorrhizal inoculation can stimulate plant growth better.

The results of the study also found that the values that explained the parameters of the observations showed significantly different results. For plant height 6 and 8 MST the administration of mycorrhizal biofertilizer dose M_3 (9 g/plant) was able to give the best results compared to the doses of other administration tested, with a value of 22.11 cm at 6 MST and 24.72 cm at 8 MST. It is assumed that plants have been infected with mycorrhizae which can absorb nitrogen in the soil which can be absorbed and utilized by plant roots to spur vegetative growth in plants. Setiadi (2011) explains that increasing the absorption of water or nutrients, especially N elements by plants will increase the metabolism of carbohydrates, proteins and growth regulators as well as vitamins to their hosts which can spur plant growth.

The results of the variance analysis showed that mycorrhizal treatment had a significant effect on the stem diameter of the seedlings, 47.50 cm^2 at the age of 6 MST and 52.50 cm^2 for the stem diameter at 8 MST, while the guano fertilizer did not significantly affect the stem diameter and no interaction between guano fertilizer and mycorrhizae. It is suspected that mycorrhizae infect the root system of cacao seedlings, so that the roots that have been infected with mycorrhizae will be able to increase their capacity in absorption of nutrients. Increasing the stem diameter of cacao seedlings occurs because it is influenced by nutrient availability factors such as nitrogen which can be absorbed by mycorrhiza. This is in accordance with Lindawati et al., (2000), nitrogen is a constituent of all protein, fat, and various other organic compounds. Nitrogen also has a role that stimulates overall plant growth, especially stems and branches.

On the parameters of observation of wet weight and dry weight, the results obtained showed that the dose of M_3 (9 g / plant) also gave the best results compared to other doses, where for wet weight 14.97 g and 10.67 for dry weight of cocoa seedlings . It is suspected that mycorrhiza is able to absorb nutrients needed by plants for its growth process. Mycorrhiza is able to absorb N, P and K elements which can increase the growth of cocoa plants. This was confirmed by Turk *et al*., (2006) that mycorrhizae were able to increase the availability of P nutrients in the soil that experienced P. health. This caused mycorrhizae to increase the growth of wet weight and dry weight of plants in plants that did not experience

mycorrhizal infection. P absorption in plants affects the physiological and morphological conditions of plants. Increased physiology and morphology lead to increased energy production in the plants body.

Interraction Effect ofGuanoand Mycorrhizal Organic Fertilizer Givingon Cocoa Seed Growth

Based on observational data and variance results showed that the interaction between the administration of guano fertilizer and mycorrhizal biofeed which was examined statistically gave results that were not significantly different for all observed parameters. This is presumably because between guano fertilizer and mycorrhizal biofertilizer does not affect each other, nor are there genetic factors that affect the growth and yield of cocoa plants so that they cannot interact with one another As stated by Gomez & Gomez (1995), that two factors are said to interact if the effect of a treatment factor changes when changes in the level of other treatment factors. Furthermore Sutedjo and Kartasapoetra (1987) stated that if one of the factors is more powerful than other factors, the other factors will be covered up, and each factor has a far-reaching nature and the nature of its work.

D. CONCLUSION

1. Giving the best guano fertilizer with a dose of G_3 (90 g/plant) was able to increase the height of the cacao seedlings at the age of 8 MST and the wet weight of the seeds.
2. Giving the best mycorrhizal biofertilizer with M_3 dose (9 g/plant) is able to increase the height of cacao seedlings aged 6 MST and 8 MST, stem diameter 6 MST and 8 MST, and wet weight and dry weight of cacao seed.
3. The interaction of guano fertilizer and mycorrhizal biofertilizer showed no significant effect on all parameters of observation.

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