ISSN No:-2456-2165 https://doi.org/10.38124/ijisrt/25jul764

Growth Response of Cacao Seedlings (*Theobroma cacao* L) with the Provision of Subsoil Layer and Palm Oil Bunch Ash

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Publication Date: 2025/07/25

Abstract: Cocoa plants are one of the plantation crops that play an important role in the economy in Indonesia. The cause of low cocoa production can be caused by plant maintenance and the lack of good cocoa seeds. One effort to produce good seeds is using organic fertilizer, namely oil palm ash fertilizer which has the ability to improve the physical, biological, and chemical properties of the soil. The purpose of this study was to obtain the best dose of oil palm ash fertilizer in increasing the growth of cocoa seedlings and the effect of giving oil palm ash on the growth of cocoa seedlings. This research was conducted at the Plantation Crop Cultivation Demonstration Garden Laboratory of Samarinda Agricultural Polytechnic from June 6 to October 6, 2023.

This study used a Completely Randomized Design method with 3 treatments and each consisting of 10 replications, the total number of plants was 30 plants, namely control without treatment (A0), treatment A1 subsoil and oil palm ash (1:1), treatment A2 using top subsoil and oil palm ash (2:1). The parameters observed were plant height, number of leaves and stem diameter.

The results of the study showed that the dose of palm oil bunch ash can increase the growth of cocoa seedlings is 2 kg of subsoil soil and 1 kg of palm oil bunch ash (2:1). Treatment P2 with the provision of subsoil soil and palm oil bunch ash (2:1) was seen to have a significant effect on all parameters observed, namely seedling height, number of leaves and stem diameter which were faster and better growth of cocoa seedlings.

Keywords*: Cocoa Seedlings, Palm Oil Bunch Ash, Subsoil.*

How to Cite: Yuanita; F.Silvi Dwi Mentari; Roby; Nur Hidayat, Daryono; Zainal Abidin; Riama Rita Manullang; Haryatie Sarie (2025) Growth Response of Cacao Seedlings (*Theobroma cacao* L) with the Provision of Subsoil Layer and Palm Oil Bunch Ash. *International Journal of Innovative Science and Research Technology,* 10(7), 1920-1924. https://doi.org/10.38124/ijisrt/25jul764

I. INTRODUCTION

Cocoa (*Theobroma cacao* L) is one of the plantation commodities that plays an important role in the national economy, especially as a provider of employment, a source of income, and foreign exchange. Cocoa also plays a very important role in regional development and agro-industry development (Kristanto, 2015).

The world's cocoa demand continues to increase, so that the expansion and increase in cocoa production are of concern to be increased by expanding the cocoa planting area in Indonesia with an average expansion rate of cocoa plant areas above 20% per year (Raharjo, 2011). Cocoa in Indonesia is mostly produced from people's gardens. The low level of public knowledge of the use of cocoa plant materials results in low production results and quality results. Efforts to develop cocoa plants need to pay attention to the cocoa seed plant materials that will be cultivated (Prastowo et al., 2006).

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The success of cocoa development is determined by the availability of sufficient seedlings and cultivation techniques. One of the actions of cocoa cultivation is the provision of quality cocoa seedlings and a good nursery process. The quality of cocoa seedlings greatly determines the growth and productivity of cocoa. Nurseries require actions such as providing fertilizers that aim to improve soil fertility and add certain nutrients to the soil. Because nurseries are the initial growth of a plant as a determinant of further growth, maintenance in nurseries must be more intensive and considered (Indonesian Coffee and Cocoa Research Center, 2005)

At this time the problems faced in cocoa nurseries in the field so that subsoil is used for planting media. Subsoil has a lower fertility value than topsoil. So as to obtain good cocoa seedling growth and increased nutrients (Prasetyo and Suriandikarta, 2006)

The type of subsoil soil is located below the topsoil with a thickness of 50 m to 100 m, is brighter in color and easier to obtain than the top layer (topsoil). Subsoil soil (bottom layer soil) is the bottom layer of soil that is generally used as a planting medium in nurseries and as a substitute for topsoil soil. Subsoil soil is easier to obtain than topsoil soil, because subsoil soil is more abundant and unlimited compared to topsoil soil which is increasingly depleted (Riniarti et al. 2013)

In general, the soil that is often used for nurseries is topsoil, because due to erosion or continuous use, the fertility of topsoil decreases, so topsoil is used as a nursery medium (Andri and Saputra, 2016).

Fertile seedlings require fertilizer to the planting medium. Fertilizer is a material added to the soil, either organic or inorganic, to add essential nutrients needed by plants for growth and development (Agusta et al. 2016)

Palm oil bunch ash is a solid waste from palm oil bunches from the burning of empty bunches (oil palm fruit bunches that have been harvested) in palm oil mills. Palm oil bunch ash from palm oil production, 20% of which is empty bunches. This ash is rich in potassium (K) and other macro and micro nutrients. Mahmud (2017) added that, The application of palm oil bunch ash has a content of N 18.48%; P 20%; K 3.51%; Mg 2.40% and Ca 1.95%.

Palm oil bunch ash is often used in nursery plants to increase soil pH, increase soil fertility and nutrient availability, can improve soil physical properties and increase plant growth (Muklis, 2022).

II. RESEARCH METHODS

A. Time and Place

➢ *Research Time*

This research was conducted for 4 months, namely from February 2023 to May 2023.

➢ *Researh Place*

This research was conducted at the location of the Plantation Crops Cultivation demonstration garden of the Samarinda State Agricultural Polytechnic

B. Tools and Materials

The tools used are hoes, scales, soil sieves, meters, watering cans, buckets, cameras and stationery.

The materials used are 2 month old ferostero cocoa seedlings, palm oil bunch ash (packed), polybag measuring 40 cm x 45 cm, and subsoil.

C. Research Treatment

This research was structured in a Completely Randomized Design (CRD)

This study used 3 treatment levels and each treatment level consisted of 10 cocoa seedlings. So the number of cocoa seedlings observed was 30 seedlings. The treatment of this study consisted of :

A0 = Subsoil
A1 = 1:1 (subsoil: palm oil bunch ash)
A2 = 2:1 (subsoil: palm oil bunch ash)

D. Research Procedure

➢ *Preparation of Planting Area*

The area used in this study has sufficient protection from sunlight, is close to a water source and is easy to monitor. The area used is clean and flat, to facilitate the arrangement of polybag for the nursery.

➢ *Preparation of Planting Media*

The planting media used is sub soil. Before being put into a polybag, the planting media must be sieved first to clean it from roots, twigs, stones and gravel and not clump. Put it in a polybag according to the treatment

➢ *Preparation of Planting Materials*

The seeds used are ferostero type cocoa seeds, the age of the seeds is 2 months, the seeds are healthy and the height of the plants is the same.

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➢ *Labeling*

Labeling is adjusted to each treatment, namely A0 as many as 10 polybags, A1 label as many as 10 polybag and A2 as many as 10 polybag.

➢ *Application of Oil Palm Bunch Ash*

Ash fertilizer from oil palm bunches is given once by mixing it with subsoil according to the treatment, after mixing it is put in a polybag.

➢ *Planting*

Planting uses 30 polybag that have been provided, before planting in the polybag, watering is carried out until the polybag is wet, then a planting hole is made using wood in the middle of the polybag with a depth of 3-5 cm, insert one by one the seeds in each polybag, then the planting medium is carefully compacted and arranged with a distance of 10 cm.

➢ *Maintenance*

- *Watering*

Watering is done until the planting medium becomes moist, the watering time is adjusted to the condition of the soil, if the soil is still wet/damp, watering is not done.

- *Weed Control*

Weed control in polybags is done manually using hands. The time for weed control is adjusted to the conditions in the field.

E. Obserbation

The research data includes observations.

➢ *Plant Height (cm)*

Measuring the height of cocoa seedlings is done by measuring from the base of the stem 1 cm from the ground surface to the highest shoot tip growth point using a meter and marking with a permanent marker. Data collection was carried out for 3 months with an observation time interval of 1 month.

➢ *Number of Leaves (Strands)*

The number of leaves observed is the increase in leaves that open perfectly and the number of leaves that do not fall off/wilt. Data collection was carried out for 3 months with an observation time interval of 1 month.

➢ *Stem Diameter (mm)*

Stem diameter by measuring the stem with a microcaliper on each cocoa seedling that has been marked using a marker in the calculation of stem diameter. Data collection was carried out for 3 months with an observation time interval of 1 month.

F. Data Analysis

The data obtained were analyzed using analysis of variance, if there was a significant difference in the treatment, then it was continued with the smallest significant difference test (LSD) at the 5% level.

III. RESULTS AND DISCUSSION

A. Results

➢ *Plant Height (cm)*

Based on the results of research observations, the height of cocoa seedlings in the A2 treatment was the highest, showing high results from the A1 and A0 treatments, the data can be seen in Table 1 below:

Table 1. Average Plant Height Data (cm) in Month 1, Month 2 and Month 3

Treatment	Average Plant Height (cm)		
	Month1	Month 2	Month 3
A0	1.5a	4.5a	6.5a
A1	2.8ab	4.9a	7.4ab
A2	3.2b	5.3b	7.9b

From table 1 it shows that the increase in height of cocoa seedlings is higher in treatment A2 (2 kg subsoil and 1 kg palm oil bunch ash) seen in the month 1 (3.2 cm), month 2 (5.3 cm) and month 3 (7.9 cm), than in treatments A1 and A0. Plant height in Treatment A1 (1 kg subsoil and 1 kg palm oil bunch ash) seen in the month 1 (2.8 cm), month 2 (4.9 cm) and month 3 (7.4 cm), while in treatment A0 (subsoil) seen in the month 1 (1.5 cm), month 2 (4.5 cm) and month 3 (6.5 cm).

In the A2 treatment, the results of the seedling height were higher than the A1 and A0 treatments. Palm oil bunch ash is rich in nutrients, especially potassium (K), and has alkaline properties, it can be used as an alternative fertilizer to increase seedling growth such as plant height (Hidayat et al, 2020). In accordance with the opinion of Hanibal (2010), the provision of oil palm bunch ash can increase nutrients in the soil and increase the vegetative growth of plant seedlings.

According to Syafruddin et al (2012), proper fertilizer application can increase plant productivity and maintain long-term soil fertility to support seedling growth such as roots, plant height, stems and number of leaves. Palm oil bunch ash also contains K2O, which functions to help in the plant growth process, especially the height of plant seedlings.

In the A0 treatment (sobsoil) the lowest plant height was seen to be the lowest of the A2 and A1 treatments, seen in the month 1 (1.5 cm), month 2 (4.5 cm) and month 3 (6.5 cm).

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This is thought to be because the subsoil does not have sufficient nutrients and there is no addition of palm oil bunch ash fertilizer. In accordance with the opinion of Sutejo (2001), that nutrients greatly affect plant growth if their availability does not match the needs of the plant growth phase, plant growth will be hampered. Plants require different times and amounts of nutrients during their growth and development.

➢ *Number of Leaves (Strands)*

From the results of observations, the number of cocoa seedling leaves was the highest in treatment A2 compared to treatments A1 and A0, showing different results, the data can be seen in table 2.

Table 2. Average Data on the Number of Leaves (Strands) in Month 1, Month 2 and Month 3

Treatment	Average Data on the Number of Leaves (strands)		
	Month 1	Month 2	Month 3
A0	1.6a	2.5a	4.6a
A1	2.0ab	3.6b	5.0ab
A2	2.5b	4.5b	6.2b

From table 2 it is shown that the largest increase in the number of leaves in treatment A2 (2 kg of subsoil and 1 kg of palm oil bunch ash) was seen in the month 1 (2.5 leaves), month 2 (4.0 leaves) and month 3 (6.2 leaves), than in treatments A1 and A0. The number of leaves in Treatment A1 (1 kg of subsoil and 1 kg palm oil bunch ash) was seen in the month 1 (2.0 leaves), month 2 (3.5 leaves) and month 3 (5.0 leaves), while in treatment A0 (subsoil) it was seen in the month 1 (1.6 leaves), month 2 (2.5 leaves) and month 3 (4.6 leaves).

In the A2 treatment, the results showed the highest number of leaves from the A1 and A0 treatments. According to Pahan (2008), the provision of oil palm ash showed an increase in plant growth, especially the number of leaves. Palm oil bunch ash contains K2O, and also contains Mg which functions as a chlorophyll component so that this element plays a role in leaf growth.

If sufficient nutrients are available in seedling growth, the photosynthesis process will run actively, cell division, elongation and cell differentiation will also run smoothly. Getting good plant growth must be balanced with the provision of the right fertilizer, if the plant lacks nutrients the plant cannot perform physiological functions, especially in increasing the number of leaves in cocoa seedlings (Agustina, 2004).

According to Sidabutar (2013), the increase in the number of plant leaves is related to the height of the seedlings, because the increase in plant height will be followed by an increase in the number of leaves, the availability of nutrients in oil palm ash, plant growth will produce more leaves.

In the A0 treatment (sobsoil soil) the lowest plant height was seen to be the lowest of the A2 and A1 treatments, seen in the month 1 (1.6 strands), month 2 (2.5 strands) and month 3 (4.6 strands). This is thought to be because the subsoil without a mixture of oil palm ash does not have sufficient nutrients. According to Sutejo (2001), incomplete nutrients can result in stunted growth and development, especially in terms of unequal uptake or absorption of nutrients and the absence of additional nutrients.

➢ *Stem Diameter (mm)*

Based on the observation results, the largest diameter was in treatment A2 compared to treatments A1 and A0, showing different results, the data can be seen in table 3.

Table 3. Average Stem Diameter (mm) in Month 1, Month 2 and Month 3

Treatment	Average Stem Diameter (mm)		
	Month 1	Month 2	Month 3
A0	0.31a	0.79a	1.68a
A1	0.39a	1.58ab	2.50ab
A3	0.45b	1.83b	3.42b

B. Discussion

From the observation results in table 3, it shows that the largest increase in diameter in treatment A2 (2 kg subsoil and 1 kg palm oil bunch ash) was seen in the month 1 (0.45 mm), month 2 (1.83 mm) and month 3 (3.42 mm), than in treatments A1 and A0. The number of leaves in Treatment A1 (1 kg subsoil and 1 kg palm oil bunch ash) was seen in the month 1 (0.39 mm), month 2 (1.58 mm) and month 3 (2.54 mm), while in treatment A0 (subsoil) it was seen in the month 1 (0.31 mm), month 2 (0.79 mm) and month 3 (1.68 mm).

On average, the stem diameter of A2 treatment was larger than A1 and A0 treatments, this is thought to be because the nutrients in oil palm ash have been fulfilled for cocoa seedlings, so these elements can help in seedling growth, especially increasing stem diameter. According to Indriani (2005), giving fertilizer to plants can increase plant growth, loosen the soil and

ISSN No:-2456-2165 https://doi.org/10.38124/ijisrt/25jul764

increase organic matter, and improve microorganisms in the soil.

According to Hardjowigeno (2010), in general, sufficient nutrients in plants, both macro and micro nutrients, are very important for the formation and growth of vegetative parts of plants such as stems, leaves and roots. The addition of nutrients will produce a large amount of chlorophyll, thereby increasing photosynthesis results, where carbohydrates produced from the photosynthesis process are used for cell division, enlargement and elongation in all parts of the plant, for example the stem, so that the diameter of the stem increases.

IV. CONCLUSION

- The dose of oil palm bunch ash that can increase the growth of cocoa seedlings is 2 kg of subsoil and 1 kg of oil palm bunch ash (2:1).
- The P2 treatment with the provision of subsoil soil and oil palm bunch ash fertilizer (2:1) was seen to have a significant effect on all parameters observed, namely seedling height, number of leaves and stem diameter which were faster and better growth of cocoa seedlings.

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