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The Growth Response of Cocoa Seed (Theobroma Cacao L.) on Mulching and Watering

Efi Said Ali[1] Asmarasari Nasution[1] M. Said Siregar[2*]
1.Agriculture Faculty, Al Azhar University, Medan, Indonesia
2.Agriculture Faculty, University of Muhammadiyah Sumatera Utara, Medan, Indonesia

Abstract
The research on growth response of cocoa seed (*theobroma cacao l.*) on mulching and watering has been done. This research uses Randomized Block Design consisting of 2 factors. The first factor is mulching (B) which consists of 3 levels and watering (W) which consists of 4 levels. Mulching showed a significant effect on the number of leaflets at 9 weeks of age and has no significant effect on plant height, leaf area, wet root weight and root dry weight. The highest number of leaves was found at B_1 level (10.77 leaves) and the lowest was at B_0 (9.56 leaves) without mulching. Watering gives no significant effect on all observed parameters of plant height, leaf number, leaf area, wet root weight and root dry weight. The highest number of leaves was found at W_3 (10.55 leaves) and the lowest was at W_1 (9.47 leaves) The interaction of mulching and watering have no significant effect on all observed parameters of plant height, leaf number, leaf area, wet root weight and root dry weight.
Keywords: growth, response, cocoa seed, mulching, watering.

1. Introduction

Cocoa plant (*Theobroma cacao L.*) is an Indonesian export commodity besides rubber, tea, oil palm and others. In Indonesia, cocoa is known since 1560, but has become an important commodity since 1951. Cocoa commodities plays an important role in the national economy. As the third most important commodity after rubber and oil palm, cocoa is one of the main sources of farmers' income in 30 provinces providing jobs (Basri, et al., 2012).

Cocoa which is one of the leading commodities of plantation besides acting as a source of farmer income and employment of farmers, also acts as a producer of foreign exchange, encourages the development of agribusiness and agro-industry, regional development and environmental conservation (Directorate General of Plantation, 2012).

Cocoa plant originated from tropical rain forest area in South America. In its home region, cocoa is a small plant in the lower tropical rainforest and grows sheltered by large trees (Indonesian Coffee and Cocoa Research Center, 2010).

Currently, Indonesia is ranked third as the world's cocoa producer after Ivory Coast and Ghana by contributing USD 1,053,446,947 (1.053 billion) of exports of cocoa beans and processed cocoa products (Diektorat Jenderal Perkebunan, 2012).

Cultivation technique is one of the factors that will bring great benefits in achieving high production and good quality, while breeding is the beginning of efforts to achieve that goal. Proper and good breeding techniques will provide great opportunities for crop success (Karmawati, et al, 2010).

Good cocoa seeds are the basic capital for farmers to earn profits in cocoa farming. Cocoa is a perennial plant that remains economical until the age of 37 years, so the mistake of choosing seeds will cause long term losses. Therefore, seed selection is a very important first step in the cultivation of cocoa (Indonesian Coffee and Cocoa Research Center, 2010).

To get a good growth and healthy, also cultivated through the improvement of cultivation technology. Mulching is one of the important factors in determining the success of a cocoa plantation business. By administering the right and regular mulch of cocoa plants will have better growing power (Umboh, 2010). According to Umboh, (2010) mulching is an effort to provide nutrients into the soil so that the physical, chemical and biological conditions of the soil in accordance with the demands of plants. So the purpose of mulching is to provide nutrients in the soil to obtain good growth and enhance soil productivity. In addition, mulch can also reduce the evaporation of water over the soil surface.

Watering given to cocoa seeds is crucial for growth and development in the nursery. Incorrect watering will disrupt the physiological processes that occur may result in stunting of growth of cocoa seedlings (Indonesian Coffee and Cocoa Research Center, 2010).

By giving mulch rice husk and mulch bagasse (bagasse) is expected to reduce evaporation and can store water in polybags longer. In this paper we reported growth response of cocoa seeds (*Theobroma cacao L.*) on mulching and watering.

2. Materials And Methods

Location of this research was at Jl. Pintu Air IV Kuala Bekala Padang Bulan Medan, of ± 25 metres above the sea levels. This study began from May 2016 until July 2016.

Materials: the cultivation of TSH (Trinidad Super Hybrid) cocoa is obtained from Kebun Aek Pancur, Pusat Penelitian Kelapa Sawit (PPKS). Mulch of rice husk and mulch of bagasse. Polybag black color size 30 x 12 cm. Wood bamboo, plywood, palm leaf stem, nails and wire. Sand, cow manure, soil top soil and burlap.

Equipments: Hoes, machetes, saws, hammer and meter, ground sieves, plastic buckets, plastic straps, permanent markers, bagung dosage, measuring cup, ruler, laptop, notebook, electric scales and stationery.

Methods

This research uses Randomized Block Design (RAK) consisting of 2 factors.

The first factor is mulching (B) which consists of 3 levels, namely: Mulch Factor B_0: no mulch, B_1: Mulch of rice husk, B_2: Mulch the bagasse.

The second factor of watering (W), water is given according to the field capacity (500 ml per polybag), consists of 4 levels, namely: Water Delivery W_1: 1 day twice (1x2), W_2: 1 day (1x1), W_3: 2 days (2x1) and W_4: 3 days (3x1).

Experimental

Land preparation

The land used for the nursery is cleared from the trash, and the grass, then flattened. To avoid rain water puddles, the drainage ditch is created around the area. The experimental plot was made with a size of 60 x 60 cm, the treatment consisted of 3 replications, the distance between replicates 100 cm in one replication consisting of 12 plots of treatment, the distance between plots 50 cm.

Shading

The direction of the shade faces east, east of 2 meters and the west is 1.5 meters. The roof is made from palm leaf stem and the direction of bed is north-south.

Grounding and polybag preparation

Polybag used black color that has size 30 x 12 cm, soil that has been mixed with sand and cow manure as basic fertilizer with ratio 2: 1: 1. The prepared media is then inserted bit by bit into the polybag until it reaches the base of the polybag and then compacted and then the soil is solid, remove the soil as deep as 2 cm from the base of the polybag to place the rice husk mulch and the bagasse mulch. Polybags that are ready to be filled are then arranged on top of the experimental plots that have been provided in an upright position.

Planting

Planting done one week after filling the soil into polybags. The seeds are planted erectly, then the soil is covered with the mulch that is provided and gives little slit for the cocoa seedlings to grow.

Maintenance of seeds

Polybag filled with sprouts arranged regularly on a flat surface soil, then performed the maintenance of seeds in the form:

Watering

The frequency of watering the seedlings is done in accordance with the treatment and the predetermined field capacity is 500 ml per polybag: W_1: 1 day twice (1x2), W_2: 1 day (1x1), W_3: 2 days (2x1) and W_4: 3 days (3x1). By using a dosage of 500 ml per polybag in the morning at 08:00 until 09:00 pm and evening at 16:00 to 17:00 pm and the implementation of watering once a day, every other day and three days once in the morning hours 08:00 to 09:00 pm. For watering treatment W_1 = (one day twice), given the amount of water, ie 250 ml for the morning and 250 ml for the day.

Weeding

This weeding is done by removing weeds that grow inside polybags or outside polybags. This is done once a week depending on the growth of the weeds.

Stitching

Embroidering is done until the age of one week after planting, and the plant as a substitute must have the same age.

Observation Parameters

Plant height (cm)

Plant height is measured from the neck of the roots to the point of growing. Measurements were made after the seeds were 4 weeks after planting and followed by the observation once a week. In order to avoid errors in subsequent measurements, each sample plant is made up of measurement boundaries and stamped in order to facilitate subsequent measurements.

Number of leaves (strands)

Leaf number observation was done by counting the total number of leaf that was formed since the plant was 4 weeks old, with 1 week observation time. Where the leaf is calculated is a leaf that has been perfect (not flus leaves).

Leaf area (cm²)

The leaf area is obtained by measuring the leaves on the nursery by using the formula (Dartius, 2005):

Log Y = - 0.495 + 1.904 log X

Where: Y = Leaf area (cm2)

X = Leaf length (cm)

Measurements were made at the 9-week-old plant after planting (at the end of the study).

Weight of wet root (g)

The wet weight of the roots was obtained in the 9-week-old plant after planting (at the end of the study). By tearing the polybag then slowly breaking the soil, separate the soil attached to the root, then cut the line between the stem and root, wash the roots clean and roots dried and roots weighed weighs.

Dry root weight (g)

Spacements that has been weighed wet roots then put into the envelope and then dioven for 24 hours with a temperature of 105º C so we get the dry weight of the roots, then weighed dry weight.

3. Results And Discussion

Results

Plant Height (cm)

The result of statistical analysis showed that mulching (B) watering (W) and its interaction had no significant effect on plant height. For more details can be seen in Table 1.

Table 1. Meaning of High Cacao Plants (cm) on Treatment of Mulching (B) and Watering (W) Age 9 Weeks After Planting.

Treatment	W_1	W_2	W_3	W_4	Average
B_0	20.30	19.30	20.07	19.67	19,84
B_1	18.10	22.30	19.63	20.63	20.17
B_2	20.17	18.87	20.20	19.20	19.61
Average	19.52	20.16	19.97	19.83	

The numbers followed by the same notation are not significant at the α = 5%

Table 1 showed that in the treatment of mulching (B) in treatment B_1 showed the highest plant height (20.17 cm) and at treatment B_2 showed the lowest plant height (19,61 cm). Treatment of watering (W) at treatment W_2 (20,16 cm) showed the highest average of plant height and at treatment W_1 (19,52 cm) showed the lowest average of plant height. The combination of B_1W_2 shows the highest plant height (22.30 cm) and the combination of B_1W_1 shows the lowest plant height (18.10 cm).

Number of Leaves (strands)

The result of the analysis showed that mulching had significant effect on leaf number at 9 weeks after planting. Treatment of watering and interaction between mulching and watering have no significant effect on leaf number. For more details can be seen in Table 2.

Table 2. Average Number of Cocoa Leaf Leaves (Hulls) on Treatment of Mulching (B) and Watering (W) Age 9 Weeks After Planting.

Treatment	W_1	W_2	W_3	W_4	Average
B_0	8.77	9.97	9.40	10.10	9.56 b
B_1	10.53	9.50	11.73	11.30	10.77 a
B_2	9.10	9.50	10.53	9.87	9.75 ab
Average	9.47	9.66	10.55	10.42	

The numbers followed by the same notation are not significant at the α = 5%

Table 2 showed that treatment B_1 showed the highest number of leaves (10.77 strands) and significantly different from B_0 (9.56 strands) but not significantly different from B_2 treatment (9.75 strands). Between treatment of B_2 and B_0 are not significant. Treatment of watering (W) on W_3 treatment (10.55 strands) showed the average number of leaf of most plants and on treatment W_1 (9.47 strands) showed the average number of leaves of the plant slightly. The combination of B_1W_3 shows the largest number of leaf plants (11.73 strands) and the combination of B_0W_1 indicates the number of plant leaves slightly (8,77 strands).

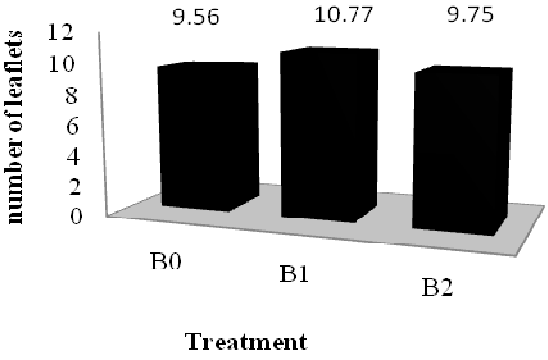

Figure 1. Graph of the number of leaflets against mulch treatment

Leaf Area (cm2)

The result of statistical analysis showed that mulching (B) watering (W) and its interaction had no significant effect on leaf area. For more details can be seen in Table 3.

Table 3. Meaning of Cacao Plant Leaf Area (cm2) on Treatment of Mulching (B) and Watering (W) Age 9 Weeks After Planting.

Treatment	W_1	W_2	W_3	W_4	Average
B_0	72.95	79.23	88.17	83.22	80.89
B_1	91.07	70.92	90.84	72.73	81.39
B_2	71.78	80.78	83.51	94.68	82.69
Average	78.60	76.98	87.51	83.54	

The numbers followed by the same notation are not significant at the $\alpha = 5\%$

Table 3 showed that mulching at treatment B_2 shows the widest leaf area (82.69 cm2) and at B_0 showed the smallest leaf area (80.89 cm2). The watering treatment (W) at W_3 treatment (87,51 cm2) showed the widest plant leaf area width and W_2 treatment (76,98 cm2) showed the smallest plant leaf area average. The combination of B_2W_4 shows the widest plant leaf area (94.68 cm2) and combination B_1W_2 shows the smallest plant leaf area (70.92 cm2).

Weight Wet Root (g)

The results of statistical analysis showed that mulching (B) watering (W) and its interaction had no significant effect on wet root weight. For more details can be seen in Table 4.

Table 4 showed that mulch treatment at treatment B_1 shows the heaviest wet weight of root (0.68 g) and at B_0 shows the lightest wet root weight (0.60 g). The W (W) treatment at W_4 treatment (0.68 g) showed the weight average of the heaviest wet roots and at the W_3 treatment (0.55 g) showed the average wet weight of the lightest roots. The combination of B_1W_4 shows the heaviest wet weight of plant roots (0.78 g) and combination B_2W_3 shows the wet weight of the lightest plant roots (0.50 g).

Table 4. Wet Weight Meaning of Root Crop Root (g) on Treatment of Mulching (B) and Watering (W) Age 9 Weeks After Planting.

Treatment	W_1	W_2	W_3	W_4	Average
B_0	0.55	0.71	0.54	0.61	0.60
B_1	0.67	0.63	0.62	0.78	0.68
B_2	0.67	0.59	0.50	0.66	0.61
Average	0.63	0.64	0.55	0.68	

The numbers followed by the same notation are not significant at the $\alpha = 5\%$

Dry Weight Roots (g)

The result of statistical analysis showed that mulching (B) watering (W) and its interaction had no significant effect on root dry weight. For more details can be seen in Table 5.

Table 5. Mean Dry Weight of Root Crop Root (g) on Treatment of Mulching (B) and Watering (W) Age 9 Weeks After Planting.

Treatment	W_1	W_2	W_3	W_4	Average
B_0	0.29	0.32	0.25	0.32	0.30
B_1	0.34	0.32	0.33	0.37	0.34
B_2	0.31	0.35	0.27	0.34	0.32
Average	0.31	0.33	0.29	0.34	

The numbers followed by the same notation are not significant at the $\alpha = 5\%$

Table 4 showed that mulch treatment at treatment B_1 shows the heaviest dry weight of roots (0.34 g) and B_0

shows the dryest dry root weight (0.30 g). Treatment of watering (W) at W_4 treatment (0.34 g) showed the meanest dry weight of root roots and W_3 treatment (0.29 g) showed the average dry weight of root roots. The combination of B_1W_4 shows the dry weight of the heaviest root roots (0.37 g) and the combination of B_0W_3 shows the dried weight of the lightest plant roots (0.25 g).

Discussion

The effect of mulch treatment on the growth of cocoa plants (*Theobroma cacao L*) in polybags.

The result showed that mulching gave significant effect to the amount of leaf at 9 weeks after planting and had no significant effect on plant height, leaf area, wet root weight and root dry weight. In plants given mulch the increase in growth is also due to the supply of nutrients are met for plant growth. This is in accordance with the opinion of Koryati (2011) which states that on the ground that is not given mulch there is a tendency of declining soil organic matter and vice versa on the soil given mulch the organic material content is quite good and tends to increase. Furthermore, mulch can reduce evaporation over long periods and because it can add soil organic matter, the ability to hold water increases.

Physiologically giving mulch gives better average growth of plants than without mulch, this is because mulching can improve the physical, biological and chemical properties of the soil. The effect of mulching can also maintain soil moisture and can reduce the rate of soil evaporation and have a good water absorption, so that the availability of water in the soil is sufficient and which can help increase nutrient uptake by plants (Anggi, 2010). This is in line with the statement Umboh (2010) that rice husk has advantages such as a source of nutrients, has a fairly good aerase and has a light mass that is good enough to be used as a planting medium.

Rice husks have hygroscopic, low density and neutral colors. Rice husk is an excellent insulating material because the husks are difficult to burn and can prevent moisture. Some studies have found that burned rice husk will produce a number of silica, for this reason rice husk provides excellent thermal insulation (Coniwanti et al, 2011).

Bagasse is a solid waste derived from sugar cane juice to be taken niranya. This waste contains many fibers and cork. This bagasse has a fresh aroma and easily dried so as not to cause a bad smell. Bagasse can be used as mulch or formulated with blotong and ash as sugar cane compost. (Anwar, 2015).

According to Hayati, et al (2010) the use of rice husk mulch is better, this is because rice husk mulch has the properties to maintain the soil moisture is higher than the mulch of bagasse because rice husk has a smaller texture and can be spread evenly over the soil surface, thus soil temperature and water availability for plants can be met so that the plant can grow and develop perfectly.

The effect of the watering treatment on the growth of cocoa plants (Theobroma cacao L) in polybags

From the results of this study it is known that watering gives no significant effect on all parameters observed. The unreal effect of the watering treatment is suspected because water is still available for plants obtained from soil-borne water and air humidity. This is in line with the statement of Setiono (2010) in addition to the availability of nutrients, the growth of plants related to fertility in influencing factors such as water and climate. The basic needs for the fertility of plant life are certain elements (nutrients, water, air, light, and temperature). Root growth is influenced by high levels of low soil temperatures in the rooting areas, as well as the availability of air in the soil also affect the respiration of some of the roots of the plant. Below the soil surface, the pores of the soil contain water and air in varying amounts. When rainwater falls in the soil surface, the water continues down through the aeration zone and partially fills the pores of the soil and resides in the pores held by the ground grains.

According Fahrudin (2009) lack of water or excess water in cocoa plant breeding causes vegetative growth such as plant height decreased compared to plant growth at optimum condition. Excess water will disrupt the chemical balance in plants that result in physiological processes running abnormally. Excess water causes the pores of the soil no oxygen while the plants require oxygen for breathing, if this condition goes on then plant growth is inhibited, the plant becomes thin, low production, quality down, The amount of ground water that is beneficial to the plant has certain limits. Such a lack of water and excess water can be difficult. Excess water itself is not toxic, but the lack of air in the stagnant soil that causes damage (Harjadi, 2011).

Effect of mulching and watering interaction treatment on cacao plant growth (Theobroma cacao L) in polybag

From the result of this research, the interaction treatment between mulching (B) and watering (W) gave no significant effect on all parameters observed. This is assumed because each treatment is mulch and water works independently so as not to affect the growth of cocoa seedlings or mulch given is not able to influence water density for plants, because the functioning of ground water content and air humidity conditions.

4. Conclusions

Mulching showed a significant effect on the number of leaves at 9 weeks of age and had no significant effect on plant height, leaf area, wet root weight and root dry weight. The highest number of leaves was found at B_1 level (10.77 leaves) and the lowest was at B_0 (9.56 leaves) without mulch. Watering gives no significant effect on all

observed parameters of plant height, leaf number, leaf area, wet root weight and root dry weight. The highest number of leaves was found at W_3 (10.55 leaves) and the lowest was at W_1 (9.47 leaves) The interaction of mulch treatment and watering gave no significant effect on all observed parameters of plant height, leaf number, leaf area, wet root weight and root dry weight.

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