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UTILIZATION OF ORGANIC FERTILIZER FROM COCOA SHELLS WASTE (*Theobroma cacao* L) AND SOY MILK DREGS (*Glycine max* L) ON THE GROWTH OF RED SPINACH (*Amaranthus tricolor* L)

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ABSTRACT

Waste of cocoa shells and soy milk dregs can cause environmental pollution. In fact, both of these wastes contain quite high macro and micro nutrient content which has the potential to increase plant and soil fertility. This study aims to utilize cocoa shells waste and soy milk dregs as organic fertilizer for the growth of red spinach. This study used a randomized block design (RBD) with 5 treatments, namely; P0 (control), P1 (1 gram of urea as positive control), P2 (70 grams of cocoa shells fertilizer), P3 (300 grams of soy milk dregs fertilizer), and P4 (a combination of cocoa shells fertilizer and soy milk dregs fertilizer). The parameters observed, among others; plant height, number of leaves and plant wet weight. The results of data analysis showed that there were significant differences between treatments P0, P1, P2, P3 and P4. Treatment P4 gave the best effect on the growth of red spinach plants among other treatments.

Keywords: Cocoa Shells, Red Spinach , Soy Milk Dregs, Waste.

INTRODUCTION

Indonesia is an agricultural country that has various agricultural commodities, including cocoa and soybeans. In recent years, these two commodities have experienced an increase in demand. One of the influencing factors is the proliferation of the chocolate and soy milk industries and the increasing demand for raw materials from these two commodities.

Jember regency is one of the producers of cocoa and soybeans, which encourages the establishment of many chocolate and soy milk industries in Jember. The increase in the use of these two commodities, turned out to have negative consequences, namely the residue left in the form of waste that is usually not used and disposed of carelessly, so that it has a bad impact on the environment. In fact, both of these wastes contain nutrients that can still be processed into new products that are beneficial and friendly to the environment.

According to Goenadi *in* Saragih and Ardian (2017), the content of nutrients or minerals in cocoa shells is still relatively high, including 1.81% N, 26.61% C-organic, 0.31% P2O5, 6.08% K2O, 1.22% CaO, 1.37% MgO, and 44.85 cmol/kg CEC. Likewise, the nutrients contained in soy milk dregs, including 27.62% crude protein, 2.95% crude fat, 52.66% BETN, 13.81% crude fiber and 2.96% ash, 0.09% Ca, and P 0.04% (Muis *et al*, 2009). Based on the nutrient content in them, both types of waste have the potential as a source of nutrients for plant growth and can be used as organic fertilizer.

Some nutrient minerals such as Nitrogen (N), Phosphorus (P), and Potassium (K) are nutrients that are needed by various plants, one of which is red spinach. According to BPS data (2012), spinach production in Indonesia in 2010 was around 152,334 tons and increased in 2011 to 160,513 tons. This shows that farmers' interest in red spinach cultivation is still high. One of the steps to make red spinach plants produce optimally is by apply organic fertilizer. Organic fertilizer from cocoa shells waste and soy milk dregs is expected to support the growth of red spinach plants.

Based on the above background, it is necessary to have a strategy for utilizing waste by making the two waste commodities above as a source of nutrients in the form of organic fertilizer. Therefore, the researcher took the initiative to turn cocoa shells waste and soy milk dregs into organic fertilizer to be applied to red spinach plants. In addition, this research is expected to be able to provide solutions for farmers in meeting nutrients for growth and increasing productivity of red spinach plants.

METHOD

Research Time and Place

This research was conducted in an experimental field in the District of Curahdami, Bondowoso Regency. The research time starts from October until December 2018.

Tools and Materials

The tools used in this research, among others; composting containers in the form of sacks or plastic, machetes/cutting machines, scales, wring cloth, basins/tubs, small plastic cups/vegetable baskets, seedbed nurseries, 2 kg polybags measuring 30 X 30, analytical scales, and rulers.

The materials used in this study, among others; 5 kg of cocoa shells, 250 ml of molasses, 180 ml of brown sugar for composting cocoa shells and 250 ml (2.5 tbsp) for composting soy milk dregs, 150 ml of EM4, 10 kg of soy milk dregs, 1 kg of bran, 1 kg of

bokasi , and water (500 ml for composting cocoa shells, 250 for adding EM4 to composting soy milk dregs), soil, red spinach seeds, urea inorganic fertilizer, organic cocoa shells fertilizer, and soybean milk dregs.

Research Design

This study is a true experimental study using a Randomized Block Design (RBD) with 5 treatments, including;

P0: Control, without application of organic fertilizer.

P1: The application of urea fertilizer as a positive control as much as 1 g/polybag (Rukmana, 2008).

P2: Application of organic fertilizer from cocoa husk waste as much as 70 gr/polybag (Akhda, 2009).

P3: Application of organic fertilizer from soy milk dregs as much as 300 g/polybag (Lestari, 2016).

P4: Application of a combination of 50% cocoa shells organic fertilizer and 50% organic fertilizer from soy milk dregs fertilizer (300 gr+70 gr).

Research Procedure

1. Composting

First, the composting of cocoa shells refers to the research of Astria and Suntari (2017). Five kg of ground cocoa shells are doused with a mixture of 240 ml of mole and 180 ml of brown sugar into 500 ml of water, then put in a sack and tightly closed, then every 3 times a day it is turned over, so that the ingredients are evenly mixed and the temperature of the cocoa shells compost drops. .

The second composting of soy milk dregs refers to the research of Suwahyono, *et al* (2014). 25 kg of soy milk dregs are squeezed and dried in the sun for ± 10 days until they are completely dry, so that about 10 kg of dregs are obtained after the drying stage. Next, mix the soy milk dregs with 1 kg of bran, 1 kg of bokasi, 250 ml of brown sugar (2.5 spoons + 250 ml of water), 150 ml of EM4 with 250 ml of water, then flatten and put into composting media, stirring every day to reduce the temperature of the compost.

2. Seeding

Seeding is done by mixing loose soil and organic fertilizer in a ratio of 1:1 (Yuliawati, 2015), mixed until it becomes homogeneous, then put into a used plastic cup that has been perforated and moisten the seedling media until it is moist, making holes in the media 0.5-1 cm deep, place the seeds and cover them with soil/seedling media (Budianto,

2016). Seedling is done 7-10 days, if the seeds have leaves ± 3 strands, then the seeds are ready to be transferred to polybags (Lestari, 2016).

3. Planting and Fertilizing

Prepare the soil, 10 day old red spinach seeds, urea fertilizer and organic fertilizer (cocoa shells and soy milk dregs). First, put the soil into a polybag, a polybag containing soil mixed with organic fertilizer according to the treatment dose. Then transfer the red spinach plant seeds that are ready for planting into the hole in the polybag that has been made according to the size of the plant.

4. Observation

Observations were made non-destructively every week to determine the vegetative growth of red spinach plants. Observation parameters include: plant height, number of leaves, and plant wet weight (only in the last week of observation).

5. Data Analysis

The data from the results of this study were statistically analyzed using the Anova test followed by Duncan's test with a 95% confidence level. Data analysis was carried out using the SPSS version 25 application or software.

DISCUSSION

The organic fertilizers produced in this study were analyzed based on their physical properties. The physical properties of both organic fertilizers were seen in the form of changes in color, texture, scent, and shape of the starting materials used in the manufacture of organic fertilizers. The process of making fertilizer or composting is carried out for 15 days. Organic fertilizers appear to be in their original color according to the materials used at the beginning of composting and turn black after 3-7 days after composting. Mature organic fertilizers are characterized by a dark brown color, loose consistency and soil-scented, as shown in Figure 1. as follows:

Figure 1. Physical Changes of Organic Fertilizer (A) Process of Making Fertilizer from Cocoa Shells (B) Results of Mature Cocoa Shells Fertilizer (C) Process of Making Fertilizer from Soy Milk Dregs (D) Results of Mature Soy Milk Dregs.

Cocoa shells, soy milk dregs and other materials that have been composted experience discoloration. Cocoa shells changes color from brown to black when it becomes fertilizer. Meanwhile, the soy milks dregs changes from white to blackish brown when it becomes fertilizer. Both types of fertilizers from these materials have a crumb or loose texture, change shape to become smoother and have a soil-scented taste. Changes in the physical characteristics of the fertilizer indicated the presence of microorganism activity from EM4 which was used in composting soybean milk dregs and MOL (Local Microorganisms) in composting cocoa husks. The physical characteristics of the two organic fertilizers are in accordance with the results of research by Wulandari, *et al* (2014) which states that organic fertilizers that have been ripe or finished will be blackish brown in color, loose in texture and smell like soil scent. Changes in the color of the fertilizer to darken occur due to the process of humification and mineralization.

The organic fertilizer made from cocoa shells and soy milk dregs is then applied to the cultivation of red spinach. Based on the results of statistical data analysis showed that the application of organic fertilizer has a significant effect on all observed parameters, including; plant height, number of leaves, and wet weight of red spinach plants. The growth in height and number of leaves of red spinach plants in the 4th week (last week of observation) can be seen in Figure 2. as follows:

Figure 2. Growth of Red Spinach Plants
(*Source*: Personal Documentation)

The application of organic fertilizer in this study had a positive effect on the growth of red spinach plants. In detail, this can be seen from the results of Duncan's further test in Table 1. as follows:

Table 1. Duncan Test Results Parameters of Plant Height, Number of Leaves and Wet Weight of Red Spinach (*Amaranthus tricolor* L)

No.	Parameter	N	Duncan Test				
			P0	P1	P2	P3	P4
1.	Plant Height	5	842,6^{a}	890,2^{a}	1886,2^{b}	1095,0^{a}	2632,6^{c}
2.	Number of Leaves	5	6,60^{a}	7,20^{a}	10,20^{b}	7,80^{a}	11,60^{b}
3.	Wet Weight	5	4,20^{ab}	2,80^{a}	12,00^{bc}	4,20^{ab}	19,80^{c}

Note: Values followed by the same letter are not significantly different

The results of further tests using Duncan's test with a 95% confidence level with SPSS version 25 program in the table above shows that treatment 4 (combination application of organic cocoa shells fertilizer by 50% and organic fertilizer from soy milk dregs by 50% (300 gr + 70 gr)) gave the best effect on all observation parameters. More clearly, this can be seen in the plant height parameters as shown in Figure 3. as follows:

Figure 3. Effect of Organic Fertilizer Treatment on Red Spinach Plant Height.

Based on the picture, it can be seen that the different treatments given to red spinach showed different effects on the height of the red spinach plant. The picture above also shows that the P0 treatment or control showed the lowest plant height growth compared to plants with other treatments. P1 treatment in the form of 1 gram of urea fertilizer did not show a significant effect compared to the control (P0), this indicates that P1 treatment with 1 gram of urea fertilizer on red spinach media was not better than P2, P3, and P4 treatments . Treatment P3 showed the increase in height of red spinach plants was better than P0 and P1 with an average height of 10.93 cm. Treatment P2 and P4 showed the best red spinach plant height growth with an average plant height of 18.86 and 26.32 cm, respectively.

Cocoa shells and soy milk dregs contain N, P, K and micro-nutrients for plant growth. Nitrogen plays a role in triggering the growth of root, stem and leaf formation (Marsono, 2011). According to Rina (2015), the elements N, P, and K play a role in stimulating cell division in the apical meristem tissue which has an impact on the process of cell elongation, resulting in plants that grow taller and produce better.

Similar to the research of Astria and Suntari (2017), the application of cocoa shells compost to mustard plants showed high uptake of nutrients such as N, P, K and C, so that it could be applied to red spinach plants. This is in accordance with the results of research by Akanbi *et al*. (2014) on the application of compost from cocoa shells which showed a significant effect on K uptake so that it had an effect on plant stem diameter and also that cocoa shells compost contains high N, which can stimulate cell elongation so that plants grow taller.

The results of research conducted by Akhda (2009) stated that the provision of efficient compost with a dose of 70 grams of azolla compost will affect the growth of red spinach plants by increasing the plant height variable. This shows that the dose of 70 grams can have an effect on the height of red spinach plants. And also the results of research conducted by Lestari (2016) revealed that fertilization with organic fertilizer from solid waste tofu dregs of 300 g gave the best results on plant height growth and was considered the most optimal dose in cultivating red spinach.

Meanwhile, the effect of organic fertilizer application on the number of leaves can be seen in Figure 4 as follows:

Figure 4. Effect of Organic Fertilizer Treatment on Number of Red Spinach Leaves.

The figure above shows that the P4 treatment produced the best effect on the number of red spinach leaves. This is in accordance with the statement of Akanbi *et al*. (2014) that the application of fertilizer from cocoa shells has a positive effect on N uptake which can increase the number of leaves. Sutedjo (2010) stated that the element N plays an important role for plant growth, improves chlorophyll performance, increases protein content, and triggers leaf growth. Hardjadi in Harahap *et al* (2015) also stated that the nutrient N optimizes photosynthesis and the results of photosynthesis can be sent to all parts of the plant for growth, such as; for leaf formation. Therefore, it can be said that the optimal composition of N elements affects the increase in the number of leaves on red spinach plants, especially in the P4 treatment.

The addition of organic fertilizers from 2 different organic materials further complements the nutrient requirements needed by plants. Rahmina, *et al* (2016) stated that the provision of soy milk dregs had a significant effect on the increase in the number of red

spinach leaves. The results showed that the treatment with the best results was the addition of 200 grams of soy milk dregs. In addition, the results of research conducted by Lestari (2016) showed that the application of a dose of 300 grams of soy milk dregs had the best effect on the increase in the number of leaves. The results of research conducted by Akhda (2009) showed that giving a dose of 70 grams of treatment was able to increase the variable number of leaves in red spinach.

While the effect of organic fertilizer application on plant wet weight can be seen in Figure 5. as follows:

Figure 5. Effect of Organic Fertilizer Treatment on Wet Weight of Red Spinach.

Figure 5. above shows that the wet weight of red spinach has increased in each treatment, treatment P1 shows the lowest wet weight compared to control (P0) of 1.31 grams. Treatments P0 and P3 showed the same average wet weight, namely 1.89 grams and 1.97 grams, respectively. The wet weight in the P2 treatment experienced a better average increase of 3.45 grams, while the highest average wet weight was found in the P4 treatment of 4.31 grams indicating a significant difference with other treatments.

The treatment with the addition of organic fertilizer with the highest composition had the highest average wet weight. This is because the nutrients provided meet the needs of red spinach plants to grow more optimally. Provision of an optimal organic fertilizer composition can increase the absorption of macro nutrients (N, P, and K) as well as various micro nutrients needed for growth and development red spinach plant.

Kaderi *in* Puspita (2013) stated that giving compost to plants can increase the ability of roots to penetrate the soil with a large nutrient uptake area so that it is more optimal in absorbing nutrients and water needed by plants. As a result, it can increase plant growth

which will affect the overall plant organ size and increase plant wet weight. The wet weight of the plant shows the water content and organic matter contained in the plant organ tissue.

Kubo (1993) stated that soybean waste products can be used as fertilizer for plants, which has a positive effect on the increase in the number of leaves. In addition, Pakaya (2015) stated that increasing the number of leaves can increase the wet weight of the plant. The results of this study are also in accordance with Rahmina's research (2017) which states that the application of tofu waste fertilizer has a significant effect on the wet weight gain of Pak choi plants. Likewise with Lestari's research (2016) that the use of solid waste tofu dregs at a dose of 300 g gives the best results on plant growth and weight, making it the most appropriate for cultivating red spinach plants. Akhda's research (2009) revealed that the dose of azolla compost had an effect on the growth of red spinach plants which increased the wet weight variable, the efficient compost dose was 70 grams.

CONCLUSION

The application of organic fertilizer from cocoa shells waste and soy milk dregs had a significant effect on all observed parameters (plant height, number of leaves, and wet weight of red spinach). The P4 treatment (combined application of 70 grams of organic fertilizer from cocoa shells waste and 300 grams of organic fertilizer from soy milk dregs) showed the best growth among other treatments.

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