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RESEARCH ARTICLE

The Effect of Palm Oil Mill Effluent and Cow Manure on the Growth and Yield of Bok Choy Plant *(Brassica Rapa L.)*

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ABSTRACT

In Indonesia, bok choy (Brassica rapa L.) is a popular vegetable whose leaves are used as food ingredients in fresh or processed ways. The treatments to increase the production of bok choy are the application of Palm Oil Mill Effluent (POME) and cow manure fertilizer. POME contains macro and micronutrients such as C, N, P, K, Ca, and Mg that *can optimize plant height, number of leaves, and plant production. This research aims to measure the effect of POME and cow manure fertilizer as well as the interaction of these fertilizers on the growth, production, and quality of bok choy. The research was arranged in a randomized block design with two factors. The first factor was Palm Oil Mill Effluent (POME) (L) consisted of L0 (0 ml), L1 (150 ml/polybag), L2 (250 ml/polybag). The second factor was cow manure fertilizer (K) consisting of K0 (0 ml) K1 (100 g/polybag) K2 (200 g/polybag). The results showed that the application of POME affects plant height at 28 DAP, the number of leaves at 28 DAP, and leaf chlorophyll content in bok choy plants. The best treatment is L1 (150 ml/polybag of POME) which increases the growth and yield of bok choy plants. Applying cow manure affects the plant height at 28 DAP, number of leaves at 28 DAP, plant fresh weight, root fresh weight, crown fresh weight, dry weight, and harvest index of bok choy plants. The best treatment was found in K1 (100 grams/polybag of cow manure) which increased the growth and yield of bok choy plants. There is an interaction between the treatment of POME and cow manure on the plant height at 21 DAP, number of leaves at 28 DAP, plant fresh weight, root fresh weight, crown fresh weight, plant dry weight, and harvest index. The best treatment is found in the interaction of L1K1 (100 ml/polybag of POME + 100 g/polybag of cow manure) which increased the growth and yield of bok choy plants.*

1. INTRODUCTION

Bok choy *(Brassica rapa L.)* is a type of mustard plant that is easy to cultivate and has excellent prospects in improving the economy of farmers and nutrition for society. Mustard can also be planted in cold and hot areas. Bok choy can grow at an altitude of 100-1000 meters above sea level (Widarto, 2008).

The production level of mustard greens is strongly influenced by soil fertility, so proper cultivation and efforts are needed to improve soil fertility to increase mustard greens production. Nitrogen is a nutrient that helps to increase vegetative growth, so that the leaves become wider, greener, and have better quality (Wahyudi, 2010).

The problem that often occurs in bok choy cultivation in Indonesia is the dependence of farmers on the use of chemicals which causes soil fertility to decrease so that the soil becomes acidic, microorganisms are killed, the environment around the land is polluted and the crops consumed contain chemical substances. The right way to overcome all of these problems is to fertilize the plants properly. The use of organic materials is very beneficial because it fulfills all the needs of soil elements. Additionally, it can act as an adhesive for soil particles so that the aggregation and structure of the soil are better. The application of organic fertilizers in plant cultivation can increase the content of organic matter (C-organic) and total content in the soil (Zulkarnain *et al*., 2013; Paiman et al., 2019; Safwandi et al., 2021; & Bellangi et al., 2022).

The application of bok choy cultivation organically will greatly reduce the impact on environmental pollution because there are no harmful chemicals used. Moreover, the production of bok choy using organic fertilizer will also increase economic value, so the opportunity for the use of organic fertilizer in the cultivation of bok choy mustard plants in the future will be quite high.

Palm oil processing plants are found in Indonesia, resulting in a high availability of solid and liquid wastes. These wastes can have an impact on the environment. Utilization of these wastes will cause benefits, such as reducing negative impacts on the abundance of waste, as well as providing organic fertilizer for plants (Zulkarnain, 2014). Palm Oil Mill Effluent (POME) contains elements of N, P, K, Ca, Mg, and various types of microbes that are useful as nutrient providers and soil improvers, so it has great potential as an organic fertilizer for crop development, especially in bok choy plants. The use of organic fertilizers in the long term is very beneficial, this is because the POME releases nutrients slowly and stores them in the soil for a long time (Ermadani & Ali, 2011).

The research results of (Anwar et al., 2019), showed that the application of POME with 200 ml/polybag dosage was effective in increasing the growth of mustard plants This shows that POME requires incubation time to break down organic matter so that it is easier for plants to absorb. Besides using POME, cow manure can also provide nutrients for plants. Manure can be said to be a complete fertilizer because it contains nutrients that are needed for plant development. The addition of organic matter from crop residues and animal manure also contributes to nutrient availability. Organic matter from animal waste (manure) is generally easy to decompose due to its low C/N ratio. Furthermore, the use of organic materials (manure) is economically cheap, easy to obtain, and doesn't need a highly technological approach so it is relatively easy to reach farmers (Abdul et al., 2008).

The purpose of the research was to determine the effect of POME and cow manure on the growth and yield of bok choy plants and to determine the interaction between POME and cow manure on the growth and yield of bok choy plants. The success of this research is very useful for the continuity of sustainable agriculture.

2. MATERIALS AND METHODS

This research was conducted in Tambon Tunong Village, Dewantara District, North Aceh Regency, and Agroecotechnology Laboratory at the Faculty of Agriculture, Universitas Malikussaleh. The research was conducted from June to August 2021.

The tools used in this research are hoes, machetes, bamboo, shovels, buckets, jerry cans, PE rope, analytical scales, rulers, cameras, stationery, and other tools needed during the research. The materials used were bok choy seeds with Green variety, top soil, cow manure, clean water, 50% Paranet, 10 kg polybag (25 cm x 40 cm), and palm oil mill effluent (POME).

This research used a factorial Randomized Block Design (RBD) with two treatment factors, which are palm oil mill effluent (L) and cow manure dosage (K). Factor I: Palm oil mill effluent (L) consists of 3 levels, which are: L0 (0 ml/polybag), L1 (150 ml/polybag), and L2 (250 ml/polybag). Factor II: Cow manure dosage (K) consists of 3 levels, which are: K0 (Control), K1 (100 g/polybag), and K2 (200 g/polybag). Thus there are 9 treatment combinations with 3 replications so that there are 81 experimental units.

The implementation of this research consisted of the preparation of planting media, seeding process, shade making, planting, fertilizing, maintenance, and harvesting. The variables observed in this research were plant height (cm), number of leaves (leaflets), chlorophyll content (cc), root length (cm), fresh weight per plant (g), root fresh weight (g), crown fresh weight (g), plant dry weight (g) and harvest index. Data analysis was done with ANOVA. If the analysis results are different, it will be followed by further Duncan's Multiple Range Test (DMRT) at the 0.05 level.

3. RESULTS AND DISCUSSIONS

3.1 Results

3.1.1. Plant Height, Number of Leaves, Plant Fresh Weight, and Root Fresh Weight.

The interaction between the treatment of palm oil mill effluent and cow manure was seen in the plant height at 21 days after planting (DAP), number of leaves at 28 DAP, plant fresh weight, and root fresh weight. Further test data on the interaction between the treatment of palm oil mill effluent and cow manure are presented in Table 1. The results showed that the interaction of the two factors could increase plant height at 21 DAP, number of leaves at 28 DAP, fresh weight of plants, and root fresh weight of bok choy plants.

Table 1. Interaction of Palm oil mill effluent and Cow Manure on Plant Height at 21 DAP, Number of Leaves at 28 DAP, Plant Fresh Weight and Root Fresh Weight.

Treatment		Plant Height at 21 DAP (cm)	Number of Leafs at 28 DAP (Leaflet)	Plant Fresh Weight (g)	Root Fresh Weight (g)
Palm oil mill effluent	Cow Manure Dosage				
0 ml/polybag	0 gram/polybag	15.20 a	10.20 a	35.20 a	1.49 b
0 ml/polybag	100 grams/polybag	18.10 a	10.17 a	37.90 a	1.59 b
0 ml/polybag	200 grams/polybag	18.90 a	10.79 a	41.76 a	2.52 a
150 ml/polybag	0 gram/polybag	16.73 b	10.27 b	35.73 b	1.77 b
150 ml/polybag	100 grams/polybag	20.22 a	12.25 a	73.41 a	3.10 a
150 ml/polybag	200 grams/polybag	19.18 b	11.18 b	39.18 b	1.75 b
250 ml/polybag	0 gram/polybag	16.36 c	10.36 c	37.36 c	1.88 b
250 ml/polybag	100 grams/polybag	19.13 b	11.15 b	52.13 b	2.12 b
250 ml/polybag	200 grams/polybag	19.81 a	12.11 a	66.81 a	3.00 a

Note: The numbers followed by the same letter in the same column are not significantly different according to the 5% DMRT test.

3.1.2. Crown Fresh Weight, Plant Dry Weight, and Harvest Index

The interaction between the application of palm oil mill effluent and cow manure is seen in the fresh weight of plant canopy, plant dry weight, and harvest index. Further test data on the interaction between the application of palm oil mill effluent and cow manure are presented in Table 2. The results showed that the interaction of the two factors could increase the crown fresh weight, plant dry weight, and harvest index of bok choy plants.

Table 2. Interaction of Palm oil mill effluent and Cow Manure on Crown Fresh Weight, Plant Dry Weight, and Harvest Index.

Treatment		Crown Fresh Weight (g)	Plant Dry Weight (g)	Harvest Index
Palm oil mill effluent	Cow Manure Dosage			
0 ml/polybag	0 gram/polybag	27.18 b	4.45 a	0.31 b
0 ml/polybag	100 grams/polybag	35.89 a	4.36 a	0.43 a
0 ml/polybag	200 grams/polybag	41.95 a	3.99 a	0.33 a
150 ml/polybag	0 gram/polybag	33.90 b	3.58 b	0.28 c
150 ml/polybag	100 grams/polybag	62.31 a	6.62 a	0.52 a
150 ml/polybag	200 grams/polybag	33.98 b	3.75 b	0.31 b
250 ml/polybag	0 gram/polybag	35.48 b	3.59 b	0.29 a
250 ml/polybag	100 grams/polybag	39.79 a	4.59 b	0.28 a
250 ml/polybag	200 grams/polybag	60.45 a	6.70 a	0.29 a

Note: The numbers followed by the same letter in the same column are not significantly different according to the 5% DMRT test.

3.1.3. Leaf Chlorophyll and Root Length

The interaction between the application of palm oil mill effluent and cow manure did not affect the leaf chlorophyll and root length of bok choy plants. However, individually both showed a significant effect. The results of further tests on the application of palm oil mill effluent and cow manure to leaf chlorophyll and root length of bok choy plants are presented in Table 3.

Table 3. Pengaruh Application of Palm oil mill effluent and Cow Manure on Leaf Chlorophyll and Root Length of Bok choy Plants

Treatment	Leaf Chlorophyll (ccl)	Root Length (cm)
Palm oil mill effluent		
L0 (0 ml/polybag)	16.87 b	20.02 a
L1 (150 ml/polybag)	17.81 ab	20.41 a
L2 (250 ml/polybag)	18.71 a	20.68 a
Cow Manure Dosage		
K0 (0 gram/polybag)	18.19 a	19.45 a
K1 (100 grams/polybag)	17.60 a	19.94 a
K2 (200 grams/polybag)	17.62 a	21.23 a

Note: The numbers followed by the same letter in the same column are not significantly different according to the 5% DMRT test.

Table 3 shows that the application of palm oil mill effluent affects leaf chlorophyll. The best treatment is L2 (250 ml/polybag). Cow manure did not affect leaf chlorophyll and root length of bok choy plants.

3.2 Discussions

The results of observations on the application of POME and cow manure to the growth and yield of bok choy plants showed that the single treatment of POME had a significant effect on the variables of plant height at 28 DAP, the number of leaves at 28 DAP, and leaf chlorophyll. The single treatment of cow manure had a significant effect on the plant height, number of leaves, plant fresh weight, root fresh weight, crown fresh weight, plant dry weight, and harvest index. The interaction of POME and cow manure had a very significant effect on the variables of plant height, number of leaves, plant fresh weight, root fresh weight, crown fresh weight, plant dry weight, and harvest index, whereas the root length had no significant effect.

In the vegetative phase observation, plant height and number of leaves get the best results in the application of POME 150 ml/polybag. These results are in line with the research conducted by Ramadhan et al., (2021) that POME 150 ml/polybag has a significant effect on plant height and number of leaves. This is believed to be because POME can break down organic matter into nutrients. POME contains microbes that play a role in decomposing organic matter into nutrients needed for plant growth. Meanwhile, the best cow manure yield is 100 g/polybag. Cow manure 100 g/polybag had a significant effect on plant height and number of plant leaves. Cow manure is suspected to contain available N nutrients that can increase the growth of bok choy plants. The need for N nutrients contained in cow manure in mustard plants is sufficient during their growth. If the N element in plants is fulfilled, then plant growth is getting better. It is known that the process of plant growth such as plant height, number of leaves, leaf width, and an increase in plant protein content requires the N element.

POME at 250 ml/polybag has a significant effect on leaf chlorophyll observations. POME at 150 ml/polybag had a significant effect on chlorophyll content. This is likely because POME contains N, P, and K which can form new cells and organize organics content in plants. This is in line with the opinion of Nyakpa (1988) who stated that the role of Nitrogen, phosphates, and potassium contained in POME play a role in the formation of new cells and are the main components of organic compounds such as amino acids, nucleic acids, and chlorophyll.

Plants' fresh weight, roots fresh weight, and crown fresh weight showed a very significant interaction between POME and cow manure. The best results of POME are in L1 (150 ml/polybag of POME), this is in line

with research (Anwar et al., 2019) which showed that the application of 150 ml/polybag of POME is effective in increasing mustard plant yields. It is assumed that POME contains nutrients such as N, P, K, Ca, and Mg as well as high organic matter to increase plant production. This is in line with the opinion of Budianta, (2004) who stated that POME has several nutrient contents such as N-total. P-total, K-total, Ca, and Mg contain high organic matter so that it can be used as organic fertilizer to increase plant production. The best results in the treatment of cow manure were found in K1 (100 g/polybag of cow manure). The application of 100 g/polybag of cow manure had a significant effect on the weight of mustard plants. This is presumably because manure can bind nutrients into the soil. Cow manure can increase the nutrient content and water binding capacity of the soil so that the plant roots can absorb nutrients more easily to increase plant production.

The interaction of POME and cow manure showed a very significant effect on plant dry weight. The interaction was able to increase the plant's weight. The best interaction results were found in the combination of L1 (250 ml/polybag of POME). This is presumably because POME can fertilize the soil and can affect the leaves. POME increases soil fertility so that the leaves will quickly open and be effective in carrying out photosynthesis. This affects the photosynthate produced which eventually increases the plant's dry weight. The best treatment of cow manure is found in K1 (200 g/polybag). Application of 200 g/polybag of cow manure had a significant effect on the plant's dry weight. It is believed that manure can provide organic matter in the soil, so that photosynthesis takes place optimally and can produce photosynthates. This is in line with Jumin (2010), which stated that the higher the amount of photosynthate, the more dry matter that can be stored.

In the observation of the harvest index, there was a very significant interaction between POME and cow manure. The interaction was able to increase the plant's weight. The best interaction results were in the combination of L1 (150 ml/polybag of POME). There is a significant effect of 150 ml/polybag of POME on the plant harvest index. It is speculated that POME contains P elements that can increase the number of branches, number of leaves, and leaf area to increase the economic value of plants. P in POME can increase plant height, number of leaves, number of branches, and leaf area up to two times. The P element also plays a role in the formation of new cells in growing tissues. The best cow manure was found in K1 (100 g/polybag). This is likely due to the optimal availability of nutrients from cow manure which increases the harvest index value of bok choy plants. This is in line with the opinion of Agusman (2004), that the higher the availability of nutrients, the better the plant absorbs nutrients for its growth and development. Controlling the availability of nutrients through fertilization to reach the ideal level will increase plant growth and production by its genetic maximum conditions (Syafruddin, 2012).

Musnamar (2005) revealed that the benefits of giving POME are that it can improve plant fertility, soil chemical conditions, soil biological conditions, soil physical conditions and is safe for humans, and does not pollute the environment. Plants will grow and develop well if the nutrients given to plants are sufficient. The average observation data showed that the application of the two types of treatment with a 150 ml/polybag of POME (L1) and 100 g/polybag of cow manure (K1) showed the best growth response.

4. CONCLUSION

1. The application of POME affects plant height at 28 DAP, the number of leaves at 28 DAP, and leaf chlorophyll content in bok choy plants. The best treatment is L1 (150 ml/polybag of POME) which increases the growth and yield of bok choy plants.
2. Applying cow manure affects the plant height at 28 DAP, number of leaves at 28 DAP, plant fresh weight, root fresh weight, crown fresh weight, dry weight, and harvest index of bok choy plants. The best treatment was found in K1 (100 grams/polybag of cow manure) which increased the growth and yield of bok choy plants.
3. There was an interaction between the treatment of POME and cow manure on the plant height at 21 DAP, number of leaves at 28 DAP, plant fresh weight, root fresh weight, crown fresh weight, plant dry weight, and harvest index. The best treatment is found in the interaction of L1K1 (100 ml/polybag of POME + 100 g/polybag of cow manure) which increased the growth and yield of bok choy plants.

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