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The Utilization of Vegetable Waste as a Nutrient Addition in Hydroponic Media for the Growth of Green Mustard *(Brassica juncea L.)*

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Abstract. Waste is a source of environmental pollution because it causes unpleasant odors, polluting water and soil and is seen as aesthetically reducing the beauty of the environment. This study aims to determine the effect of using vegetable waste as a nutrient addition to hydroponic media on the growth of mustard greens (Brassica juncea L.). The method used in this study was an experimental method with a randomized block design (RBD) consisting of 5 treatments with 6 repetitions, namely P0 (control), P1 (20ml POC + 40ml AB mix), P2 (30ml POC + 30ml AB mix), P3 (40 ml POC + 20 AB mix), and P4 (60 ml POC). This research was conducted at the Center for Agricultural Mechanism Development - Tangerang, Banten, and was conducted in March - July 2018. The observation variables were plant height, fresh weight, and plant dry weight. The research data were analyzed using the normality test and homogeneity test as a prerequisite. It was then tested with ANAVA test and the Leastest Significant Difference test 5% (LSD 5%). The results of this study indicated that the application of liquid organic fertilizer from vegetable waste to P2 with a dose of 30 ml POC + 30 ml AB mix gave the best results on plant height parameters with an average of 36.93 cm, fresh weight with an average of 41, 79 grams, and dry weight with an average of 2.34 grams. From this study, it can be concluded that the utilization of vegetable waste as an addition of nutrients to hydroponic media has an effect on the growth of mustard greens (Brassica juncea L.).

1. Introduction

The increasing development of agricultural cultivation technology seems to be inversely related to the availability of agricultural land. The conversion of agricultural land to industrial land has urged agribusiness actors to deal with narrow land to increase production. The erosion of agricultural land is not only a problem in developing countries, but in developed countries as farming activities will be disrupted (Rahmaningsih, 2015).

The large number of people in Indonesia creates land that should be used as a medium for the community to grow crops to increase production to be used as settlements, offices and industry (Chanjula, et al 2016). In the early 1980s, hydroponic cultivation techniques began to enter and develop in Indonesia. Indonesian people welcomed hydroponic cultivation techniques because these techniques could produce high quality vegetable commodities. This situation made hydroponic technique became a solution to increasing the food needs of the Indonesian people (Sutanto, 2015).

Green mustard plant (Brassica juncea L.) is a vegetable plant with a sub-tropical climate, but is well adapted to tropical climates. The need for green mustard plants is increasing along with the increasing human population and the health benefits of consuming these mustard plants (Ibrahim, 2018; Jayawardana, et al. 2016). Green mustard is a vegetable that is beneficial to the human body because of its nutritional content. Director of Vegetable and Biopharmacy Cultivation at the Directorate General of Horticulture, Ministry of Agriculture, Yul H. Bahar, said that vegetable consumption in Indonesia is still 73 kg/capita/year, below the Food and Agriculture Organization of the United Nations (FAO)'s standard, which is 91.25 kg/capita/year (Rakhman et al., 2015).

An important factor that needs to be considered in increasing the production of mustard caisim is the sufficient availability of nutrients. The availability of nutrients is an important factor for the growth of the caisim mustard plant. Novriani (2014) states that one way to meet the nutrient needs of the caisim mustard plant using hydroponic media is to use liquid organic fertilizer (POC) (Vodoumnou, et al. 2016). The advantage of using POC is that it can provide macro and micro nutrients and it has hygroscopic properties (dissolves easily) to be used immediately without requiring a long time interval to be absorbed by plants (Varma, et al. 2016).

Waste is a source of environmental pollution because it causes unpleasant odors, it can pollute water and soil, and is seen as aesthetically reducing the beauty of the environment. Waste from market activities that are not properly managed will cause environmental pollution (Reben, et al. 2010). These wastes still contain high water content and contain organic materials in the form of carbohydrates, proteins and fats (Singh, et al. 2012). One way that can be done to manage market waste is to process it into liquid compost (Liquid Organic Fertilizer) because liquid organic fertilizers penetrate the soil more quickly and can be utilized by plants (Latifah et al., 2012).

Based on the explanation above, it is hence necessary to conduct a research on the utilization of vegetable waste as an addition of nutrients in hydroponic media for the growth of mustard greens (Brassica juncea L.).

2. Methodology

This research was conducted from March to July 2018. The method used was an experimental method with a randomized block design (RBD) of 5 treatments and 6 replications. The RAK 5 x 6 was obtained through Frederer's formula, namely: $(t-1)(n-1) \geq 15$, where t is the number of treatment groups and n is the number of replications. The material used in this study was vegetable waste obtained in the South Tangerang market, as much as 2 kg as the basic material for making liquid organic fertilizer and used to provide control treatment, P1 (20 ml), P2 (30 ml), P3 (40 ml) , and P4 (60 ml).

Research Procedures

Seeding Seeds

The process of seeding seeds involved soaking the seeds in warm water (Iqbal, 2016) and cutting the rockwool into small squares. It was followed by preparing a container or tray to place the rockwool then wetting the rockwool with water until the rockwool pores were filled with water. Afterwards, the seeds were placed on top of the rockwool that have been given small holes. The seeds were watered 2 times a day in the morning at 08.00 and afternoon at 16.00. Sowing was carried out for ±± 2 weeks or until 3-4 leaves appeared.

Making POC from Vegetable Waste

This involved preparing a tub or bucket with a lid and washing it thoroughly. Afterwards, I took the vegetable wastes from the market and chopped them up to 2 kg. The bucket was then filled with 5 liters of water taken from the tap, which were mixed with 100 ml of EM4. 1 liter of coconut water was poured into the bucket alongside ½ kg of brown sugar and 100 ml of sugar solution. It was then stirred until it was mixed. After that, I added 2 kg of chopped vegetable waste into the bucket and I stirred until all the ingredients were mixed. I covered the bucket tightly for up to 15 days. Every day the

liquid organic fertilizer was stirred for just 5 rounds and after 15 days, the liquid organic fertilizer was filtered to make it clean and free from solids. After all of these, the finished fertilizer was ready for use.

Making Hydroponic Media
Making hydroponic media using the wick system method according to Iqbal (2016) is as follows:

Prepare a used impraboard and then cut it to a size slightly above the nutrition bath so that the impraboard sheet can cover the tub. Punch the impraboard to the size according to the net pot using a hole. Punch 6 holes on each impraboard. Then, install the flannel cloth in the gap at the bottom of the net pot as a wick. After that, place the net pot in each hole on the impraboard then cover the nutrition tub with the impraboard sheet. Hydroponic media is then ready to use.

Transferring Plant Seeds
If the mustard seeds have started to grow 3-4 leaves, then the plant is ready to be transferred to the hydroponic growing media that has been made. I chose seeds that were tall and had the same number of leaves and then transferred them from the pot to hydroponic media (rockwool). Each rockwool was planted with 1 green mustard seed.

Plant Care
Treatment was carried out on the planting medium by stirring the media every day in the morning at 08.00 so that there was no clumping.

Harvesting
Harvesting was done 30-35 days after transplanting (HSPT).

Data Collection
Parameters observed in this study were plant height measured from the base of the stem to the point of growth. Fresh weight was carried out after harvest. The mustard plant samples were cleaned first and freed from the remaining water in the plant using newspapers or tissues. After that, all parts of the plant were weighed using digital scales. The dry weight was calculated after the plants were dried in the sun or by using an oven and weighed until the weight was constant.

Data Analysis
Data analysis was tested for normality using chi square (x2) and Barlett test to determine the homogeneity of data variance. When the data was normally distributed and had homogeneous variance, the data was then analyzed using one-factor analysis of variance (ANOVA) and followed by the Bnt test to find out the real difference between treatments.

3. Result and Discussion

Based on the results of research and observations that have been made from the utilization of vegetable waste as an addition of nutrients to hydroponic media on the growth of mustard greens (Brassica juncea L.) at the age of 30 HSPT (Days After Transplanting) including plant height, fresh weight, and plant dry weight mustard greens. The average results have been tested by BNT in general. The data for the three parameters are listed in table 1.

Table 1. Results of the average growth parameters of mustard greens aged 30 HSPT.

Treatments	Growth Parameters		
	Plant Height (cm)	Fresh Weight (g)	Dry Weight (g)
P_0	30.75^{b}	29.24^{ab}	1.37^{ab}

P_1	35.38^{cd}	35.13^{bc}	1.89^{bc}
P_2	36.93^{d}	41.79^{c}	2.34^{c}
P_3	28.80^{ab}	21.78^{a}	1.27^{a}
P_4	26.47^{a}	19.60^{a}	1.04^{a}

Note: Figures followed by different letters show a significant difference at the 5% significance level.

Plant Height

Based on table 1, it can be seen that in the treatment of 30 ml of vegetable waste POC + 30 ml of AB mix (P2), the highest average plant height was 36.93 cm. The lowest average yield was in the 60 ml POC treatment of vegetable waste (P4) with an average value of 13.85 cm. The normality test on plant height data showed normal results with a value of 4.79.

The homogeneity test of plant height data showed a homogeneous variance result with a value of 7.2090. This means that the data could be continued with the one-factor ANAVA test which showed the results of $F_{count} = 9.0404 > F_{table}$ 1% = 4.18 and F_{table} 5% = 2, 76, indicating that the POC mixture of vegetable waste with AB mix had an effect on the height of mustard greens at 30 HSPT. The LSD test calculation showed that the treatment of a mixture of 30 ml POC with 30 ml AB mix (P2) was significantly different from the control treatment (P0)

Plant Fresh Weight

Based on table 1, it can be seen that the treatment of a mixture of 30 ml POC vegetable waste + 30 ml AB mix at P2 showed the highest average yield on plant fresh weight with a value of 41.79 grams, and 60 ml POC treatment at P4 showed the lowest average yield. with a value of 19.6 grams. The normality test showed that the fresh weight data of mustard plants was normally distributed with a value of 7.2. In the homogeneity test, the results obtained were 5.8115 which indicated that the fresh weight data of the mustard greens had a homogeneous variation.

The one-factor ANOVA test was carried out when the fresh weight data were said to be homogeneous. The ANOVA test the results were $F_{count} = 5.320903118 > F_{table}$ 1% = 4.18 and F_{table} 5% = 2.76, which means that the POC mixture of vegetable waste with AB mix had an effect on fresh weight of green mustard plants at 30 HSPT. Furthermore, the LSD test showed that the treatment of a mixture of 30 ml POC with 30 ml AB mix (P2) was significantly different from the control treatment (P0).

Plant Dry Weight

Based on table 1, it can be seen that the POC treatment of 30 ml vegetable waste + AB mix 30 ml on P2 had the highest average value, namely with a value of 2.34 grams, while in the POC treatment of 60 ml vegetable waste at P4 had the lowest average value, namely 1.04 grams. The normality test showed that the dry weight data of the mustard plant was normally distributed with a value of 9. The homogeneity test with a value of 3.3475 showed that the data of the mustard plant dry weight had a homogeneous variant.

The one-factor ANOVA test was carried out after the dry weight data had homogeneous variance. The one-factor ANOVA test showed that the value of $F_{count} = 6.335486 > F_{table}$ 1% = 4.18 and F_{table} 5% = 2.76, which means that the POC mixture of vegetable waste with AB mix affected the dry weight of mustard plants. Furthermore, the LSD test on 30 ml POC treatment of vegetable waste with 30 ml AB mix (P2) was significantly different from the control treatment (P0).

The research data in table 1 shows that there was a significant effect on each treatment of vegetable waste liquid organic fertilizer on the parameters of plant height, plant fresh weight and plant dry weight. In treatment 2 (P2) 30 ml AB mix + 30 ml, POC showed the best results for parameters of height, fresh weight and dry weight compared to other treatments (Table 2). The nutrient content in the ratio of 30 ml POC and 30 ml AB mix was thought to cause accelerated cell division in the apical meristem (shoots). The nutrients contained in the POC contain elements of N, P, K, Mg and Ca which

would stimulate cell division and cell elongation. affecting the growth of green mustard plant height (Toruan et al., 2015).

In P2, the plant height parameter showed the highest yield of 35.8 cm. According to Subandi et al. (2015) the increase in absorption of P elements would increase plant vegetative growth. The P element can help form energy in the form of ATP, which functions for the absorption of other nutrients. This ATP would be used as a source of energy by plants to absorb other elements such as the N element which function to increase plant height (Kozheunikova, 2017). Based on the results of tests conducted at the Research Institute for Spices and Medicines (Balitro), the Phosphorus (P) nutrient contained in the POC of market vegetable waste was 71.54 ppm, and the nutrient nitrogen was 0.003%. In addition to N and P elements, micro-elements such as Zn also function in plant growth, namely in the division of meristem cells. According to Sastro (2016), the Zn nutrient contained in AB mix was 1.5 grams and based on the results of the test, POC in Balitro Zn was at 0.46 ppm. The results of the Balitro test showed that the N contained in the POC of vegetable waste was only a little but it could cause the best results on plant height parameters. This was presumably because there was a buffer from AB mix which contained micro nutrients Zn.

The parameter of fresh weight and dry weight of treatment 2 (P2) was able to increase the fresh weight by 41.79 grams. The K nutrient which also plays a role in the photosynthesis process. If the potassium nutrient in the leaves decreases, the rate of CO2 assimilation will decrease and plants with the availability of this nutrient can increase the plant crown (Novriani, 2014). In addition, the function of potassium is to strengthen plant tissue and play a role in the formation of antibodies that can fight disease and drought (Parnata, 2010). The availability of sufficient nutrients in liquid organic fertilizers will increase the photosynthetic process that occurs in plants by increasing the photosynthetic process. With this, it would also increase photosynthetic yield and plant dry weight as a result of the photosynthesis process (Sukawati, 2010).

Based on the results of the research that has been carried out, the lowest results were found in treatment 4 (P4) with a concentration of 60 ml of vegetable waste POC on the parameters of height, fresh weight and plant dry weight. Plant height parameters was with an average yield of 26.47 cm, the parameter of fresh weight was with an average yield of 19.6 grams and the parameter of dry weight was with an average yield of 1.04 grams. This was due to the lower value of the nutrient content in the POC of vegetable waste, which caused the nutrient needs of the mustard greens were not fulfilled. It is reinforced by Lakit (2010) who proposed that plants that experience a lack of availability of essential nutrients, its metabolism would be disrupted. The symptoms caused by plants due to a lack of these essential nutrients included stunted (stunted) growth of roots, stems and leaves. Based on the results of the POC test at Balitro Nitrogen, it contained very low amounts of only 0.003%, Phosphorus of 71.54 ppm, Potassium 71.1 ppm, organic C 0.14%, Sodium 0.005%, Calcium 0.016%, Magnesium 0.008%, Fe 9.2 ppm, and 0.46 ppm Zn. Meanwhile, according to the MOA, the minimum technical requirements for organic liquid fertilizer are organic C with min 6%, Nitrogen, P2O5, and K2O of 3-6%, total Fe 90-900 ppm, available Fe 5-50 ppm, and Zn 250-5000 ppm.

In P4 treatment with a concentration of 60 ml, POC alone could not meet the nutrient needs of mustard plants, making growth and production of mustard plants was inhibited. In addition, there was no buffer for other elements from AB mix. Plant growth would be optimal if the nutrients needed are available in quantities and forms needed by the plant. This is reinforced by Novriani (2014) who discovered that maximum growth and production will be achieved if the supply of nutrients to plants is in optimal or balanced conditions, because a deficiency or excess of one nutrient would reduce the efficiency of other elements and can reduce the quantity and quality of plants. In addition, the possibility of high POC concentrations causes the media to become concentrated as a result of the absorption of the plants is disturbed.

4. Conclusion

From this study, it can be concluded that the utilization of vegetable waste which is used as organic liquid fertilizer as an addition of nutrients has an effect on the growth of mustard greens in the three

parameters, namely height, fresh weight and plant dry weight. In treatment 2 (P2) with a dose of 30 ml of Liquid Organic Fertilizer + 30 ml of AB mix gave the best results on plant height, fresh weight and dry weight of mustard greens. Nonetheless, treatment 4 (P4) with a dose of 60 ml of liquid organic fertilizer provided the lowest yield on height, fresh weight and dry weight of mustard greens.

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