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The Effect of Bokashi and Ab Mix for The Growth of Red Lettuce (Lactuca Sativa Var. Red Rapids) Using DFT (Deep Flow Technique) Hydroponic System

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Hydroponics is an agricultural system because it can be cultivated in various places, such as villages, cities, open land, and apartments. A hydroponic system can be used throughout the year, regardless of the season. In this study, 4 types of nutrition were used, namely cabbage leaf bokashi, chicken manure bokashi, combination of chicken manure bokashi with cabbage leaf bokashi, and AB Mix nutrient solution. Bokashi is a Japanese word that means fermented organic matter, a process that converts food waste and similar organic matter into a soil amendment that adds nutrients for the plants. The AB Mix solution was prepared by mixing 83 grams of AB Mix A and 83 grams of AB Mix B and letting them dissolve in 2 liters of water. Vegetables are in great demand by the public because they have high nutritional content and are beneficial to health. One type of vegetable that is needed by almost everyone is red lettuce (lactuca sativa var. red rapids). Almost all types of plants can be grown in a hydroponic farming system. The purpose of this study was to determine the growth of red lettuce using AB Mix solution in comparison with the three types of bokashi solution, by measuring the width of the leaf and the length of the plant roots. The experiment was tested by Anova and Duncan analysis with a level of alpha of 0.05. The result of the experiment is that the use of AB Mix solution has the best plant growth in comparison with the three bokashi solutions.

Keywords: *AB Mix, red lettuce (Lactuca sativa Var. Red rapids), hydroponics deep flow technique, Bokashi*

Currently hydroponic cultivation is gaining popularity because of efficient resources management and quality food production. Soil based agriculture is now facing various challenges such as urbanization, natural disaster, climate change, use of chemicals and pesticides which is depleting the land fertility. For successful implementation of commercial hydroponic technology, it is important to develop low-cost techniques which are easy to operate and maintain; require less labour and lower overall setup and operational cost.

The DFT hydroponic system is a method of cultivating hydroponic plants by placing plant roots in a deep layer of water, the layer depth ranges from 4 – 6 cm. The principle of the DFT hydroponic system is to circulate the plant nutrient solution continuously for 24 hours. This hydroponic technique is called hydroponic system (Wirawan et al., 2004).

Cabbage leaves are one of the most widespread plants in Indonesia and even outside Indonesia. Cabbage leaves contain active compounds such as alkaloids, flavonoids, tannins, saponins, polyphenoes, glycosides and steroids which provide pharmacological effects including antioxidant, analgesic, anti-inflammatory, anticarcinogenic, diuteric, antidiabetic, antibacterial and antifungi. (Hardjana, 2016).

AB Mix fertilizer consists of concentrated solutions A and B. The macronutrient group chemicals used include potassium nitrate, calcium nitrate, potassium phosphate and magnesium sulfate. Meanwhile, the micronutrients used are iron (Fe), manganese (Mn), copper (Cu), zinc (Zn), boron (B), chlorine (Cl), and nickel (Ni). For iron (Fe) to dissolve, the formulation is added with a chelating agent. Apart from that, additional humic acid can also increase nutrient uptake. Fertilizer A can contain a mixture of calcium nitrate, potassium nitrate and Fe chelators. Fertilizer B can contain a mixture of potassium di-hydro phosphate, ammonium sulfate, potassium sulfate, potassium nitrate, magnesium sulfate, copper sulfate, zinc sulfate, as well as various other microelements esterase, antihyperuricemia, antimicrobial agents, and cytotoxic agents that are believed to grow in nature (Sitorus, 2019).

Red lettuce (Lactuca sativa var. Rd rapids) is a type of Leaf lettuce, this type of lettuce has red, wide, thin leaves which are clustered and look curly. The transfer of agricultural land to non-agricultural land such as residential and industrial areas cause a reduction in land availability for farmers. One technology that can be applied to solve this problem is hydroponic technology. In hydroponic plant cultivation, the factors that become obstacles are environmental factors. A suitable environment will increase the growth and yield of lettuce plants. Lettuce is a short-lived agricultural commodity and has high economic value. In 2012, Indonesia imported 145 tons of lettuce. Each type of lettuce has various varieties (Mutakin et al., 2019).

Red lettuce has a morphology that is not much different from green lettuce. The genetic source of red lettuce plants is thought to come from West Asia and America, the cultivation of red lettuce then spread to the Mediterranean region. The central areas for planting red lettuce in Indonesia are Cipanas (Cianjur) and Lembang (Bandung). Red lettuce plants are a type of annual leaf vegetable plant, short-lived, and in the form of shrubs.

The advantage of growing hydroponically is that it produces plants of good quality, free of chemicals and healthy. Hydroponics is also useful for meeting the family's food needs and helping to preserve the environment, this is because hydroponics can increase the oxygen content in the surrounding air to make it fresher (Hayati et al.., 2021).

The development of demand for hydroponic vegetables in Indonesia tends to increase every year, however data on the demand for hydroponic vegetables which shows the high consumer demand in Indonesia is not yet statistically available, because it has not been well documented. Based on the results of a survey summary through several articles regarding the demand for hydroponic

vegetables conducted by the author, the increase in demand for hydroponic vegetables increases by 10% -20% every year (Savira & Prihtanti, 2019).

The purpose of this research is to determine the effect of Bokashi and AB Mix on the growth of red lettuce. AB Mix fertilizer is quite pricy in the market, and to reduce expenses, we try to use bokashi because it is much cheaper, and it will help the farmers to gain more income in their agriculture activity. This technique in which the root will be put in the water about 4-6 cm is called closed hydroponic technique.

Methodology

In this study, the effect of chicken manure liquid bokashi on the development of red lettuce plants when compared to other organic fertilizers, namely a combination of chicken manure and leaf bokashi, and AB mix. The growth of red lettuce will be carried out in a DFT (Deep Flow Technigue) Hydroponic system in the Green House Experimental Garden, FMIPA, Indonesian Adventist University, Bandung.

Method of Study

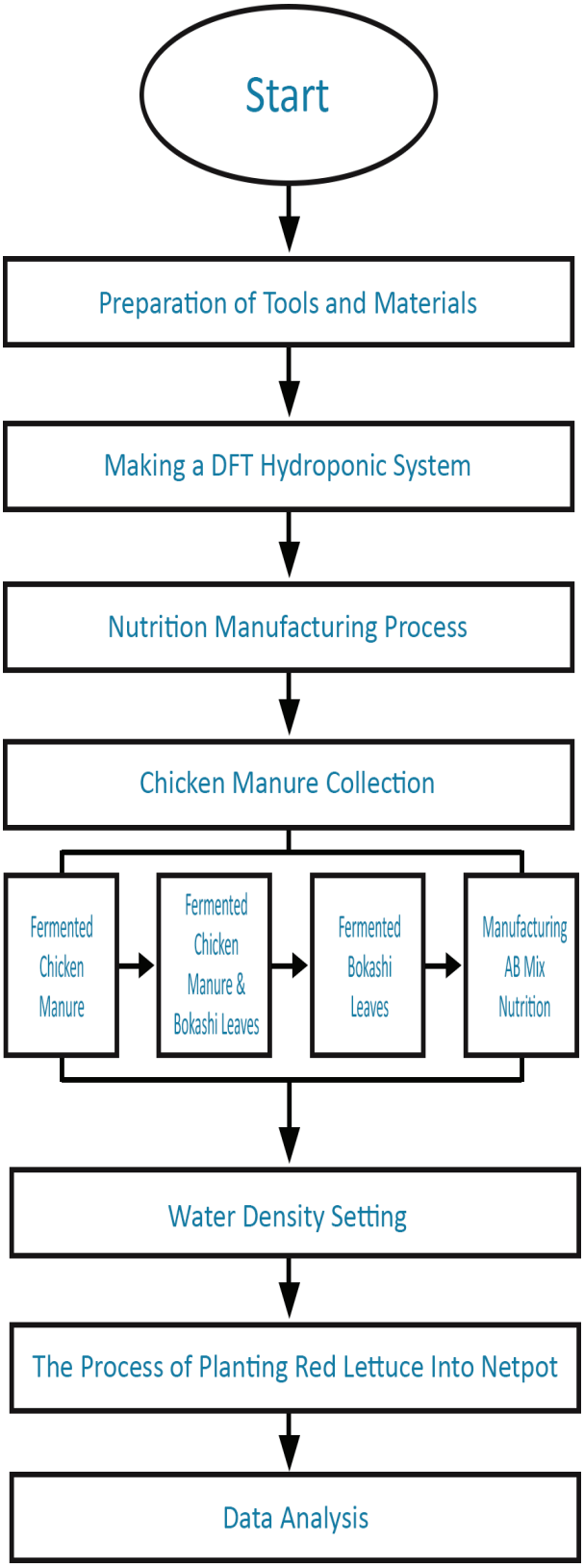
This study used a randomized factorial pattern consisting of 4 factors. The first factor was nutritional treatment (N), namely: N1 = AB Mix nutrition, N2 = Chicken manure nutrition, N3 = Leaf Bokashi, and N4 = Chicken manure and leaf Bokashi blend. The second factor was the treatment of the planting medium (M), namely: M1 = AB mix, M2 = Chicken manure fertilizer, M3 = Mixture of chicken manure and leaf bokashi, M4 leaf bokashi. We used a total of 128 red lettuce plants, 32 for AB mix, 32 for chicken manure, 32 for a mixture of chicken manure and leaf bokashi, 32 for leaf bokashi.

Research Design

The media used in planting plants is the DFT (Deep Flow Technique) system. Water is channeled to the roots of the plants in a shallow way, as a planting medium. We use water other than soil.

Figure 1

Deep Flow Technique System



Making a DFT (Deep Flow Technique) Hydroponic System

In making the DFT hydroponic system, the first step is to prepare a 2.5-inch diameter pipe with a 4m long pipe, 1-inch inlet pipe and 1-inch outlet pipe. A 20-liter nutrient tub and a submersible pump, which is used to convey the nutrient solution to the red lettuce plants. In this DFT system, the distance between the planting holes is 20 cm, the hole diameter is 4.5 cm and the distance between the pipes is 21 cm. The principle of the DFT Hydroponic system is to flow the nutrient solution continuously for 24 hours in a closed flow circuit. The nutrient solution in the holding tank is flowed using a water pump through the planting gutter through the inlet pipe, then the nutrient solution in the planting pipe is flowed back to the holding tank through the outlet pipe and returns to circulation. In the DFT Hydroponic system, it distributes nutrients to plants through flowing water with a height of about 1-3 cm. The DFT Hydroponic system requires an electric current to circulate water into the gutters using a pump.

Chicken Manure Collection

Chicken droppings were obtained from red chicken farms in Sido Mulyo Village. The technique of making chicken manure is by using a sack and taken by hand wearing gloves and putting it in the sack.

Fermented Chicken Manure

Utilization of chicken manure as liquid organic fertilizer must first go through the fermentation stage, by following the steps below:

1. Put 3 kg of fermented chicken manure into a bucket containing 10 liters of water.
2. Add ¼ kg of brown sugar and 50 ml of EM4 slowly and simultaneously pour into a bucket and stir until the sugar dissolves in the chicken manure.
3. The bucket is tightly closed and left for 14 days and after enough time has passed, the bucket is opened.
4. Fermentation is successful if it no longer smells of chicken manure. Chicken manure liquid organic fertilizer is ready to be filtered and put in a holding bucket and ready to be used.

Fermented Bokashi Leaves

In making Bokashi using leaf vegetables which will be fermented from solid form, is converted into liquid form by mixing manure with 6 kg of leaf vegetables, then mixed with 50 ml EM4 with 10 liters of water then filtered, then wait for two weeks to be applied to the DFT Hydroponic system.

Making Hydroponic Nutrient Solutions

In this study, 4 types of nutrients were used, namely chicken manure, leaf vegetable bokashi liquid fertilizer, a mixture of leaf bokashi and chicken manure, and AB mix nutrient. AB mix nutrient solution was carried out by dissolving AB mix A (83 grams) and AB mix B (83 g) into 2 liters of water, then stirred until evenly mixed, then these nutrients are stored separately in a closed plastic bucket.

Water Density Setting

In measuring the concentration of Hydroponic solutions, it is needed to maintain healthy plants. The thickness of the solution must be adjusted to the type and age of the plant. The definition of TDS (Total Disolved Solid) is the amount of compaction dissolved in water, so a TDS or PPM (Part Per Million) meter can be interpreted as a tool for measuring the amount of particles or solids. The method of measurement is to dip the tip of the tool into the nutrients which have been mixed with water and which have been stirred, it will be read on the screen display, in PPM units, the PPM required for the type and age of the plant. Red lettuce plants 400-1000 PPM.

Planting Red Lettuce in Hydroponic Media

Before the vegetable plants are transferred into the pots that are already available, there are several things to do so that the plants that are transferred will grow well. The preparations are as follows:

1. Make sure the DFT (Deep Flow Technique) system functions properly and does not leak.
2. Make sure the drain is not clogged. If it is clogged use a hard object to open the way.
3. Make sure the pipe is not mossy and ready to use.
4. Make sure the reservoir is not mossy and clean.
5. Make sure the water in the DFT is filled.
6. The flow of water in DFT Hydroponics with the speed of water flowing from the first pipe to the last is one liter in one minute.
7. Make sure the plants transplanted into the crop plot are healthy and not damaged.
8. Plants that already have more than one root in the rockwool or have shown a size of more than 1-2 cm, will be transferred to the DFT medium.

Maintenance

After the plants are planted in the pavers, there are several things that must be done so that the planted plants can grow well.

1. Every day the flow of water must be observed so that it is not clogged.
2. Make sure the nutrient water in the tub is always full.
3. If the water has decreased to the minimum limit, immediately refill the water until it is full, then give the nutrients.
4. Do not let the bucket dry because it can cause damage to the pump.
5. If there are plants that die, take it immediately because it can transmit the disease.
6. If the plant dies, replace it with a new one immediately.

Statistical analysis

Observational variables

1. Plant height was calculated from the base of the stem to the tip of the longest leaf when the plant was 4 weeks.
2. Leaf width and measurements were made when the plants were 4 weeks.
3. Root Length, measured from the base of the longest root at the end of the observation (harvest).

The procedure for calculating variation statistics with a completely randomized design pattern on one-way factorial ANOVA.

Results and Discussion

This chapter explains the results of the data that has been carried out and displayed in the form of analysis tables along with their discussion. After observing, the data obtained is the measurement data of plant height, leaf width and root length of red lettuce plants. Data analysis with One Way ANOVA statistics, descriptive and Duncan's test.

Height Measurements of Red Lettuce Plants (Lactuca sativa Var. Red rapids)

This study used 4 variations, namely leaf bokashi, ABmix (control), a combination of leaf bokashi and chicken manure, and chicken manure. Table 4.1 is descriptive of the effect of leaf bokashi, AB mix (control), a combination of leaf bokashi and chicken manure, chicken manure on red lettuce plant height.

Table 1

Height of Red Lettuce Plant (Lactuca sativa Var. Red rapids)

Nutrition	N	Average	SD	SE	Minimum	Maximum
Chicken manure	10	11,770	3.0004	.9488	7.5	15.9
Chicken Manure + Bokashi Leaves	10	15,420	1.3096	.4141	13.1	17.5
Leaves Bokashi	10	9,850	2.3090	.7302	7.0	13.0
AB Mix	10	20,410	2.9849	.9439	16.9	25.5
Total	40	14,363	4.7295	.7478	7.0	25.5

From the results of Table 1 the nutrients that gave the highest average amount were AB mix with an average of 20,410, while the second average was a combination of bokashi leaves and chicken manure with an average15,420, the third average of chicken manure with an average of 11,770, and the fourth average of leaf bokashi with an average of 9,850.

Table 2

One-way ANOVA Statistical Test Results on Red Lettuce Plant Height

	Sum of Squares	Df	Mean Square	F	Significant
Between groups	647,743	3	215,914	34,603	.000
In groups	224,631	36	6,240		
Total	872,374	39			

In Table 2 the height between the variables with the sum of the squares between groups is 647,743, df 3, and the mean square is 215,914 with F34,603 with Sig .000. For the fertilizer variable described in the first hypothesis, namely, the application of leaf bokashi fertilizer, AB mix (control), a mixture of chicken manure and leaf bokashi, and chicken manure Ho is accepted, which means that the application of the four types of fertilizer has no effect on the height growth of lettuce (Lactuca sativa Var. Red rapids) shows acceptance with a value of p = .000 (greater than α = 0.05) so it can be concluded that there is an effect of giving leaf bokashi nutrition, AB mix (control), leaf bokashi + chicken manure and chicken manure on growth red lettuce (Lactuca sativa Var. Red rapids).

Duncan's Test on the Number of Height Measurements of Red Lettuce (Lactuca sativa Var. Red rapids)

The results of Duncan's multiple range test on the height of red lettuce (Lactuca sativa Var. Red rapids) are shown in Table 3.

Table 3

Duncan's Results

Nutrition	N	Subset for Alpha = 0.05		
		1	2	3
Leaves Bokashi	10	9,850		
Chicken manure	10	11,770		
Chicken Manure + Bokashi Leaves	10		15,420	
AB Mix	10			20,410
Significant		094	1,000	1,000

The results from the table above show that the control 3 AB mix of the total results of measurements of the height of red lettuce plants as many as 20,410, is the main contributing variable to the significance of the results of the test and statistical analysis.

Number of Leaf Width Measurements of Red Lettuce (Lactuca sativa Var. Red rapids)

From the descriptive results in the calculations that have been obtained from this study, it can be seen in Table 4 with the highest results of the average leaf width is AB mix, namely 10,400, the second average of bokashi leaf width is 4,500, the third average of chicken manure + bokashi leaves is 9,420 and the average is 4,950 chicken manure.

Table 4

Leaf Width of Red Lettuce (Lactuca sativa Var. Red rapids)

Nutrition	N	Average	SD	SE	Minimum	Maximum
Chicken manure	10	4,950	2.0855	.6595	2.4	9.5
Chicken Manure + Bokashi Leaves	10	9,420	1.7255	.5456	7.4	12.5
Leaves Bokashi	10	4,500	1.6546	.5232	2.3	6.9
AB Mix	10	10,400	1.2987	.4107	8.0	12.0
Total	40	7,318	3.1232	.4938	2.3	12.5

One Way ANOVA Test of Red Lettuce (Lactuca sativa Var. Red rapids) Leaf Width

Descriptive data has been obtained, so go straight to the one-way ANOVA test to better know the variable gain of each given nutrient, in Table 5.

Table 5

Results of One-Way ANOVA Test on Leaf Width of Red Lettuce (Lactuca sativa Var. Red rapids)

	Sum of Squares	Df	Mean Square	F	Significant
Between groups	274,657	3	91,552	31,163	.000
In groups	105,761	36	2,938		
Total	380,418	39			

From the nutritional variables described in the second hypothesis, leaf bokashi, AB mix, chicken manure + leaf bokashi and chicken manure could not have an effect on the growth of red lettuce (Lactuca sativa Var. Red rapids) leaf width, accepted with p = .000 (greater than α = 0.05), so it can be concluded that there is an effect of giving leaf bokashi nutrition, AB mix (control), chicken manure + leaf bokashi and chicken manure on the growth of red lettuce (Lactuca sativa Var. Red rapids). After one-way ANOVA statistics were carried out and significant results were found, then it was continued to Duncan's multiple range test to see which nutrients had the most influence on the acceptance of the hypothesis.

Duncan's Test on Measurement of Leaf Width of Red Lettuce (Lactuca sativa Var. Red rapids)

The results from Table 6 show that the control 2 AB mix with the acquisition of the number of calculations from the width of the leaves of the red lettuce plant is 10,400, which is a variable contributing to the significance of the test results and statistical analysis.

Table 6

Duncan Table for Fertilizer Differences in Leaf Width of Red Lettuce (Lactuca sativa Var. Red rapids)

Nutrition	N	Subset for Alpha = 0.05	
		1	2
Leaves Bokashi	10	4,500	
Chicken manure	10	4,950	
Chicken Manure + Bokashi Leaves	10		9,420
AB Mix	10		10,400
Significant		561	.209

Root Length Measurements of Red Lettuce (Lactuca sativa Var. Red rapids)

In this study, 4 variations were used, namely leaf bokashi, AB mix (control), a mixture of chicken manure + leaf bokashi, and chicken manure. Table 7 is a descriptive analysis of the effect of leaf bokashi, AB mix (control), a mixture of chicken manure + leaf bokashi, and chicken manure on root length of red lettuce plants.

Table 7

Length of Root of Red Lettuce (Lactuca sativa Var. Red rapids)

Nutrition	N	Average	SD	SE	Minimum	Maximum
Chicken manure	10	6,090	2.7811	.8795	1.5	10.0
Chicken Manure + Bokashi Leaves	10	11,660	2.8968	.9161	6.9	15.5
Leaves Bokashi	10	8,720	4.0773	1.2893	3.3	16.5
AB Mix	10	24,240	7.1960	2.2756	15.5	40.5
Total	40	12,678	8.3184	1.3115	1.5	40.5

From the descriptive results in the calculations that have been obtained from this study can be seen in table 4.7 with the highest results of the average root length is AB mix, namely 24,240, the second average root length of chicken manure is 6,090, the third average root length of a mixture of chicken manure + bokashi leaves is 11,660, and the average root length of 8,720 is leaf bokashi.

One Way ANOVA Test of Red Lettuce (Lactuca sativa Var. Red rapids) Root Length

In Table 8 it can be seen that the root length between variables with the sum of the squares between groups is 1937,837, Df 3, and the mean square is 645,946 with F 30,566 with Sig .000. For the fertilizer variable described in the fourth hypothesis, namely, the application of leaf bokashi fertilizer, AB mix (control), a combination of chicken manure + leaf bokashi, and chicken manure Ho is accepted, which means that the application of the four types of fertilizer does not affect the growth of the root length of red lettuce plants (Lactuca sativa Var. Red rapids) showed acceptance with a value of p = 0.000 (greater than α = 0.05), so it can be concluded that there was leaf bokashi nutrition, AB mix (control), a mixture of chicken manure + leaf bokashi, and manure chickens on the growth of red lettuce (Lactuca sativa Var. Red rapids).

Table 8

One Way Anova Test on Root Length of Red Lettuce (Lactuca sativa Var. Red rapids)

Root Length	Sum of Squares	Df	Mean Square	F	Significant
Between groups	1937,837	3	645,946	30,566	.000
In groups	760,793	36	21.133		
Total	2698630	39			

Duncan's Test on Measurement of Root Length of Red Lettuce (Lactuca sativa Var. Red rapids)

The results of Duncan's multiple distance test on root length of red lettuce (Lactuca sativa Var. Red rapids) can be seen in table 9. It was shown that the control 3 AB Mix with the sum of the measurement results of the root length of red lettuce plants as many as 24,240, was the main contributing variable to the significance of the test and statistical analysis.

Table 9

Duncan Measurement of Root Length of Red Lettuce (Lactuca sativa Var. Red rapids)

Nutrition	N	Subset for Alpha = 0.05		
		1	2	3
Leaves Bokashi	10	6,090		
Chicken manure	10	8,720	8,720	
Chicken Manure + Bokashi Leaves	10		11,660	
AB Mix	10			24,240
Significant		209	.161	1,000

Conclusion

AB Mix is the best solution in this research when it comes to the measurement of plant height, leaf width, and root length, of red lettuce plant (Lactuca sativa var. Red rapids), followed by combination of chicken manure and bokashi leaves, chicken manure, and bokashi leaves.

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