EFFECT OF MICROBUBBLES ON THE GROWTH OF MUSTARD PAK CHOI (*Brassica rapa* L.) IN WICK SYSTEM HYDROPONICS

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ABSTRACT

Mustard pak choi (*Brassica rapa* L.) is one of the vegetable plants used in the research object. The wick system is a simple hydroponic method that uses a wick as a link between nutrients and the roots of the growing media. With a flat container, the hydroponic system wick will use an aerator to provide oxygen needs. The research purpose is expected to design a hydroponic wick system with the addition of microbubble treatment and to determine the effect of treatment duration and quantity of microbubble technology on the growth of mustard greens, namely the number of leaves, leaf area, wet plant weight, plant root length, and leaf greenness index. Microbubble technology is a device that produces or delivers air bubbles with a diameter of fewer than 200 micrometers in water and provides optimization of the rate and amount of oxygen transfer. Mustard Pak choi will be observed from the number of leaves, leaf area, wet plant weight, plant root length, and leaf greenness index and, compared with control plants, is expected to increase the productivity of mustard Pak choi. The method applied examines the relationship of systematic changes of the independent variables of one or more variables from the experimental group. Data processing used a completely randomized factorial design with five repetitions and two factorials. The first factor was microbubble treatment for 3, 6, and 9 hours, and the second used 1, 2, and 3 diffuser outputs and one without control treatment. The results showed that the effect of time and the number of microbubbles had no significant effect on plant morphology. Still, the application of dissolved oxygen to the microbubbles impacted the growth of mustard Pak choi compared to the control and treatment. The results showed that oxygen causes the breakdown of nutrients that are more easily absorbed and increases plant quality

Keywords: Aerator; Dissolve Oxygen; Hydroponics Wick System; Microbubble; Mustard Pak Choi

INTRODUCTION

Indonesia is very well known as a rural country, which means a country that relies on the agricultural sector perspective as a source of livelihood. Agriculture is one of the sectors that dominate people's income in Indonesia. Along with the population increase in Indonesia, horticultural commodities in meeting people's food needs will continue to increase. Coupled with large cities that grow with increasing market demand for vegetable commodities, it will be challenging to find agricultural land (Virha *et al*., 2020). A problem in the agricultural sector is the use of agricultural land converted into settlements which affects agricultural production. With the reduction of agricultural land, agricultural products will decrease. Given these problems, the right solution is needed to change the community's mindset to provide superior agricultural products with land use, namely using one of the hydroponic planting systems. The objectives of the research are expected to design a wick hydroponic system with the addition of microbubble treatment and to determine the effect of treatment duration and quantity of microbubble technology on the growth of mustard greens, namely the number of

leaves, leaf area, wet plant weight, plant root length, and leaf greenness index.

One of the techniques in hydroponics that can be used is the wick hydroponics system or circulating axis system. Wick system hydroponics is one of the simplest hydroponic methods by using the axis as a link between nutrients and the roots of the growing media, passive axis system because nutrients will flow into the media from the container using an axis (Julianto *et al*., 2021). Wick hydroponics system has passive properties because there are no moving parts in the media, and fertilizer application and irrigation are easily controlled. The principle of the wick hydroponic system is easy to apply because it has a low difficulty level. Materials can be obtained from used goods, such as Parallon pipes, mineral plastic bottles, plastic water cups, and other materials. In this case, it is beneficial for these items to save costs from making wick hydroponic systems. The wick hydroponic system technique was developed as a simple cultivation technique that does not require electricity for circulation. Still, the problem with this technique is that it has a low oxygen content for the root system (Krisnawati *et al*., 2014). The advantages of using a wick hydroponic system are that plants can get an adequate water supply and provide continuous nutrition, easy maintenance, and low equipment costs. Wick hydroponics system needs to rely on water for planting and not only use water for plant needs; oxygen is still required to complete the criteria for good growth (Putera, 2015). If the ethylene level in the roots is high, the roots start to bruise and will die. Therefore, if oxygen is present in the aquatic environment, it will be better for the root system to absorb nutrients. Microbubble technology is used to provide optimal results for wick hydroponic systems.

METHOD

The data processing method used to analyze the research on the effect of using microbubble technology is the Completely Randomized Factorial Design (CRFD) method, which consists of 2 factors. The first factor is the provision of microbubble treatment for 3 hours, 6 hours, and 9 hours. The second factor is the quantity of microbubble usage to the number of diffusers used, namely 1st diffuser, 2nd diffuser, and 3rd diffuser. The results of the study will be compared with control treatments to determine whether the use of microbubbles affects the growth of mustard Pak choi with a wick system.

The tools and materials needed for the use of microbubble technology in wick hydroponic systems for the growth of mustard Pak choi (*Brassica rapa* L.) are as follows: Bucket 71 liters for a place to mix the nutrient solution and water, Seedling Tray for seeding, Rosston type L2 aerator output 2x4 L/min for dissolving air and oxygen into water, Microbubble Diffuser Air Stone type ASW-10108 output 4 L/min to create micro-sized air bubbles in water, ST-148 socket/UTICON terminal 4 holes for distributing electrical energy to the aerator, TDS-3 Meter to measure the level of a given nutrient solution, Konica Minolta Portable Chlorophyll SPAD-502 PLUS for measuring plant chlorophyll content, Digital Scale-1000g/0.1g for measuring the mass of Pak choi mustard plants, 1000 ml Measuring Cup for measuring liquid ingredients, Lux Meter HS1010 to measure light intensity, MPOW Habor Hygrometer Indoor Thermometer for measuring the temperature and RH (humidity) of the environment, pH meter to measure the acid-base level of water, Mustard Pak choi Seeds (*Brassica rapa* L.) for research material seeds, for planting media for Mustard Pak choi seeds, Netpot for storing hydroponic plants in the installation, Plastic Containers to hold water, nutrients and plants, Wick for distributing nutrient water solution to plant roots, AB Mix Nutrition to provide a supply of water and mineral nutrients.

The research method applied in this research is experimental research methods (experiments) in the field. Examining the causal relationship with systematic changes like the independent variable (manipulation) of one or more variables from the experimental group. The experimental results will be compared with the treatment that was not manipulated. The method used was a completely factorial randomized block

design with five repetitions and two factorials with three levels each which can be explained in the Table 1.

Table 1. Test treatment factor

Time(t) \ *Diffuser* (pcs)	D1	D2	D3
t1	t1D1	t1D2	t1D3
t2	t2D1	t2D2	t2D3
t3	t3D1	t3D2	t3D3

In this study, ten treatments were obtained, specifically:
t0D0 : without diffuser
t1D1 : 1 output diffuser for 3 hours
t2D1 : 1 output diffuser for 6 hours
t3D1 : 1 output diffuser for 9 hours
t1D2 : 2 output diffuser for 3 hours
t2D2 : 2 output diffuser for 6 hours
t3D2 : 2 output diffuser for 9 hours
t1D3 : 3 output diffuser for 3 hours
t2D3 : 3 output diffuser for 6 hours
t3D3 : 3 output diffuser for 9 hours

The number of test materials was 120 plants and plant data collection were 50 plants. Data processing carried out at the beginning of planting will be transferred to a hydroponic wick system using a microbubble by measuring the number of leaves (pieces per plant). Measurements made when reaching the harvest stage were testing plant wet weight (g), leaf area (cm^2), plant root length (cm), and leaf greenness index. The data obtained will be analyzed using ANOVA (analysis of variance), which tests the difference from the average obtained by the data results. The analysis is used to compare the variance to determine whether or not there are differences or changes in the test data results. The results of variance that have a very significant effect will be tested using the Least Significance Different (LSD) test at 1%. If the test results show a significant impact, it will be tested with an LSD test at 5%.

RESULT AND DISCUSSION

The result for dissolved oxygen content (Figure 1) showed that the t0D0 treatment had a low value for dissolved oxygen in the water. Treatment with the effect of time and microbubble quantity showed an increase in DO value in water content. Adding dissolved oxygen will cause water ripples and oxygen content that lasts long enough in the water and will increase the flow of nutrients. Microbubble treatment can accelerate the absorption of nutrient water by mustard Pak choi because the nature of dissolved oxygen causes the breakdown of nutrients that plants more easily absorb. The results obtained compared to the supporting literature showed relevant results, where in plant growth, there was an increase in oxygen concentration and aeration pressure from dissolved oxygen, so the growth of mustard Pak choi increased (Fauzi *et al*., 2013).

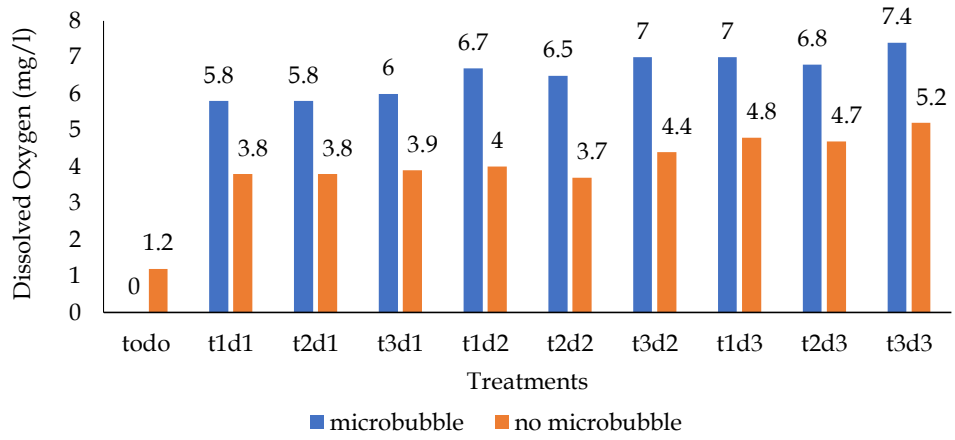

Figure 1. DO (Dissolve Oxygen) Value for Each Tub

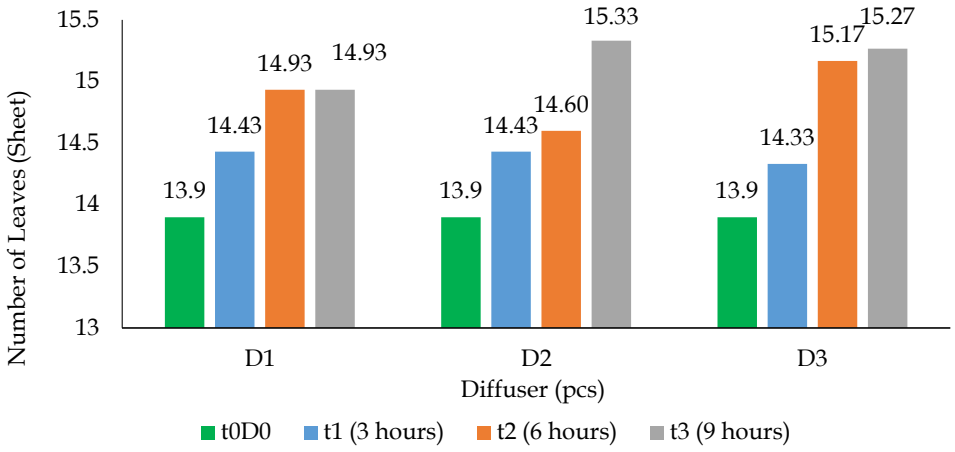

Figure 2. The Average Number of Leaves (Strands) per Treatment for 35 Days

Table 2. Variety prints analysis number of leaves

SV	db	JK	KT	F_{count}	F_{tabel} 5%	F_{tabel} 1%	Notation
Treatment	8	629.41	78.68	2.46	2.21	3.05	*
N	2	161.88	80.94	2.53	3.26	5.25	tn
S	2	154.71	77.36	2.42	3.26	5.25	tn
NS	4	312.81	78.20	2.45	2.63	3.89	tn
Error	36	1150.82	31.97				
Total	44	1780.23					

Data collection for measuring the number of leaves of the mustard Pak choi plant (Figure 2) will be carried out by counting the number of leaves on each plant. The number of leaves was measured once a week after mustard greens were planted until harvesting was carried out. The calculation of the number of leaves will be carried out on leaves in good condition and leaves condition have opened perfectly.

Comparison of controlled plants with time and microbubble treatment increased the number of leaves, followed by an ANOVA test to determine whether or not there was a significant effect. Based on the results of the research that has been done, the results of data processing show that variations in the use of the influence of time and quantity of microbubbles have no significant effect on the development of the number of leaves on the hydroponic mustard plant Pak choi wick system (Table 2). Compared to the literature, the results of the study did not get significant marks. The number of leaves will be followed more than the height of the plant because the formation of carbohydrates, environmental factors, quantity and length of time affect the plant growth process whether there is a change or not (Yuliani, 2015).

Wet weight was carried out by weighing the plant when just harvested (35 HST), using an analytical balance to obtain it in grams. Then the data was processed to determine the average wet weight for each treatment (Figure 3). Comparison of controlled plants with time treatment and microbubble has a graph that fluctuates on wet weight, which will be continued with an ANOVA test to determine whether or not there is a significant effect.

Based on the results of the analysis of the variance of time variation and the number of microbubbles, the effect is not significant (Table 3), so it cannot be continued with the LSD test at the level of 1% and level of 5% because there is no very significant effect. The results obtained are not in accordance with the comparison of the literature because the research calculations obtained values that are not significant or there is no effect from the treatment, while the content of the oxygen solution given can increase or increase plant growth (Fauzi *et al*., 2013).

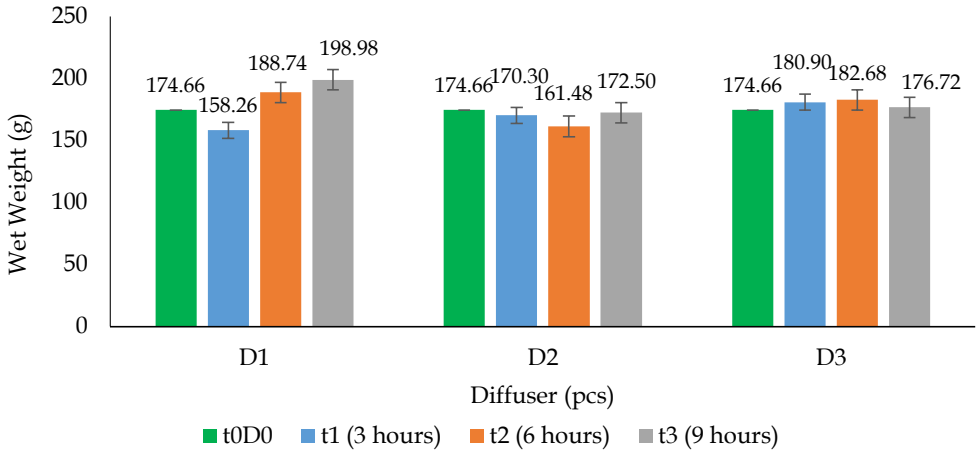

Figure 3. The Average of Plant Wet Weight

Table 3. Variety print analysis of plant wet weight

SV	db	JK	KT	F_{count}	F_{tabel} 5%	F_{tabel} 1%	Notation
Treatment	8	85629.62	10703.70	1.62	2.21	3.05	*
N	2	21364.45	10682.23	1.62	3.26	5.25	tn
S	2	28066.82	14033.41	2.12	3.26	5.25	tn
NS	4	36198.34	9049.59	1.37	2.63	3.89	tn
Error	36	237774.56	6604.85				
Total	44	323404.18					

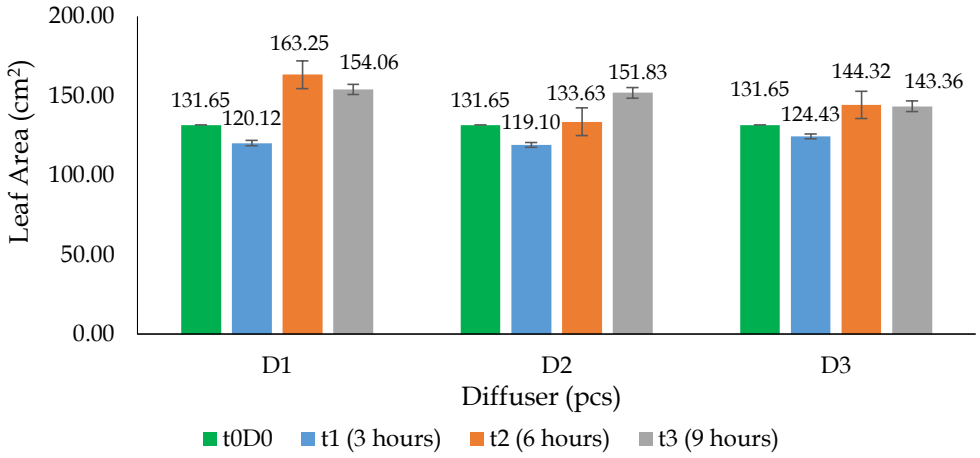

Figure 4. The Average of Leaf Area

Leaf area measurements were carried out at 35 HST using diagram paper or millimeter blocks. Later the leaves would be drawn according to the pattern on the diagram paper, the length times width method, and each plant would be drawn and calculated (Figure 4). Comparison of controlled plants with time treatment and microbubble has an increasing, and fluctuating graph on leaf area will be continued with ANOVA test to determine whether or not there is a significant effect.

Based on the results of the analysis of the variance of time variation and the number of microbubbles, the effect is not significant, so it cannot be continued with the LSD test at the level of 1% and level of 5% because there is no very significant effect

(Table 4). The results obtained are not in accordance with the comparison of the literature because the research calculations obtained values that are not significant or there is no effect from the treatment, while the content of the oxygen solution given can increase or increase plant growth (Fauzi *et al*., 2013).

Root length was measured starting from the root neck to the tip of the plant roots at 35 HST. The tool used for the measure is a ruler, so root length data is obtained in cm. Comparison of controlled plants with time treatment and fluctuating graph microbubble on plant root length, in each treatment which showed an increase and also decreases with increasing days after planting, exposure time, and quantity of microbubble given and compared with the controlled treatment (Figure 5) and will be continued with the ANOVA test to determine whether or not there is a significant effect.

Table 4. Variety print analysis leaf area

SV	db	JK	KT	F_{count}	F_{tabel} 5%	F_{tabel} 1%	Notation
Treatment	8	64022.99	8002.87	2.44	2.21	3.05	*
N	2	13421.36	6710.68	2.05	3.26	5.25	tn
S	2	18199.53	9099.77	2.78	3.26	5.25	tn
NS	4	32402.10	8100.53	2.47	2.63	3.89	tn
Error	36	117974.98	3277.08				
Total	8	64022.99	8002.87	2.44	2.21	3.05	

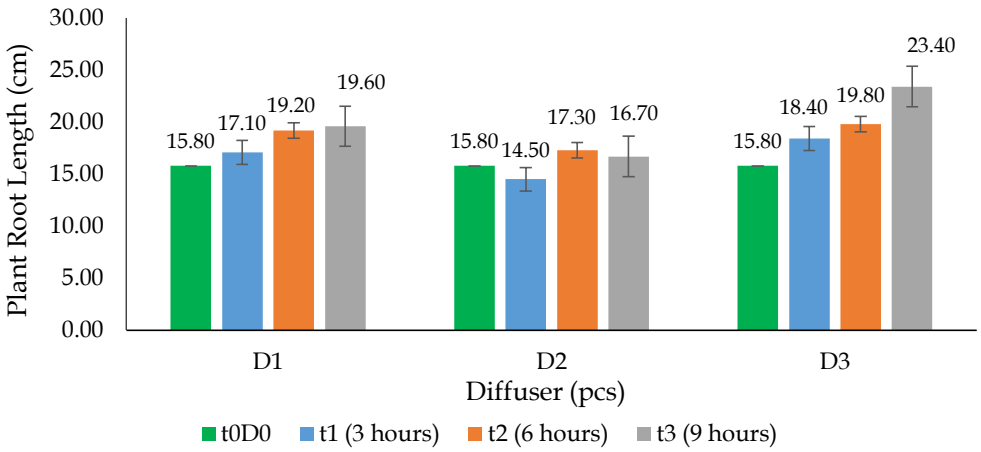

Figure 5. The Average of Plant Root Length

Table 5. Variety print analysis plant root length

SV	db	JK	KT	F_{count}	F_{tabel} 5%	F_{tabel} 1%	Notation
Treatment	8	1095.40	136.93	2.19	2.21	3.05	*
N	2	294.63	147.32	2.35	3.26	5.25	tn
S	2	85.63	42.82	0.68	3.26	5.25	tn
NS	4	715.13	178.78	2.85	2.63	3.89	tn
Error	36	2255.40	62.65				
Total	44	3350.80					

Based on the analysis results of variance of time variation and the number of microbubbles, the effect is insignificant (Table 5), so it cannot be continued with the LSD test at the level of 1% and level of 5% because there is no very significant effect. The results obtained are not in accordance with the comparison of the literature because the research calculations obtained values that are not significant or there is no effect from the treatment, while the content of the

oxygen solution given can increase or increase plant growth (Fauzi *et al*., 2013).

Leaf chlorophyll measurement using the SPAD tool by clamping the middle, right, and left of the mustard Pak choi on the sensor section of the tool, taking the greenish index data of mustard Pak choi at 35 HST. Comparison of controlled plants with time and microbubble treatments had an increase and fluctuating graph on the greenness of the leaves (Figure 6). The ANOVA test will continue to determine whether or not there is a significant effect.

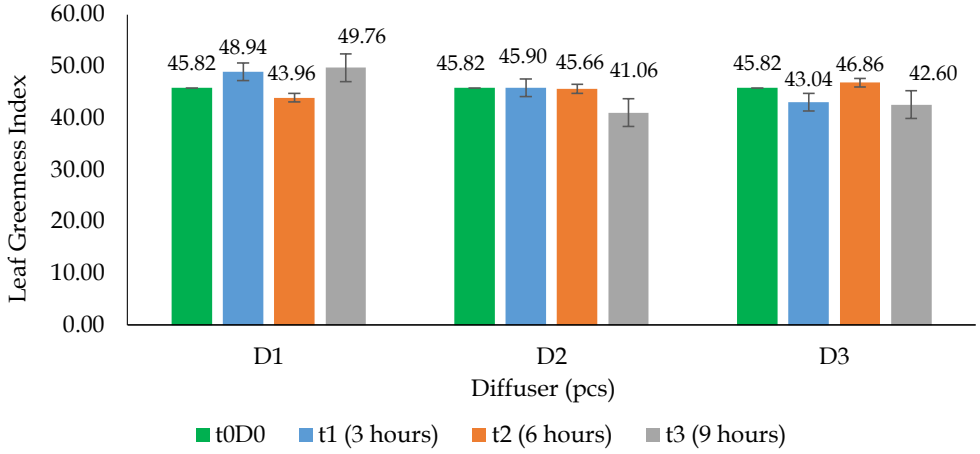

Figure 6. The Average of Leaf Greenness Index

Table 6. Variety print analysis of leaf greenness index

SV	db	JK	KT	F_{count}	F_{table} 5%	F_{table} 1%	Notation
Treatment	8	6034.96	754.37	2.32	2.21	3.05	*
N	2	1517.20	758.60	2.33	3.26	5.25	tn
S	2	2111.78	1055.89	3.24	3.26	5.25	tn
NS	4	2405.98	601.50	1.85	2.63	3.89	tn
Error	36	11723.67	325.66				
Total	44	17758.63					

Based on the ANOVA results of time variation and the number of microbubbles, the effect is insignificant, so it cannot be continued with the LSD test at the level of 1% and level of 5% because there is no very significant effect (Table 6). The results obtained are not in accordance with the comparison of the literature because the research calculations obtained values that are not significant or there is no effect from the treatment, while the content of the oxygen solution given can increase or increase plant growth (Fauzi *et al*., 2013).

CONCLUSION

The number of microbubbles on the growth of the mustard Pak choi in the wick hydroponic system did not significantly influence the morphology of plant growth. The microbubble quantity did not significantly affect the number of plant leaves, wet plant weight, plant root length, leaf area, and leaf greenness index. Still, DO (Dissolve Oxygen) was affected by water quality, which was used as a medium for Pak choi mustard plants. That is because the microbubble treatment can accelerate the absorption of nutrient water by mustard Pak choi. After all, the nature of dissolved oxygen causes the breakdown of nutrients that plants absorb more easily.

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