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Effectiveness Of Water And Air Pumps On The Growth And Production Of Lettuce (Lactusa sativa L.) On Various Kinds Of Media With Hydroponic Systems

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ABSTRACT

Lettuce (*Lactusa sativa* L.) is one of the vegetable commodities that can be grown in tropical and subtropical areas. This research was conducted in March-June at the Green House of FP.UTP. This study uses the factorial method with a completely randomized design (CRD), a factorial pattern consisting of two factors. 1) Use of a Pump (P_0: Without a Water Pump (Aquarium Pump) and Air Pump (Aerator), P_1: Using only a water pump, P_2: Using only an air pump, P_3: A combination of using a water pump and air pump. 2) use of planting media (S) Rockwool; cocopeat, moss, repeated three times. The results showed 1) Pump use treatment (P) had a very significant effect on the parameters of plant height (cm), stem diameter (cm), number of leaves (strands), leaf width (cm), fresh plant weight (g), dry weight plants (g), consumption weight (g), number of leaves consumed (strands), and root length (cm) on the growth of lettuce (*Lactusa sativa* L). 2) The treatment using media (S) had a very significant effect on the fresh weight parameters of the roots (g). It significantly affected the root volume parameters (mm) on the growth of lettuce (*Lactusa sativa* L). 3). The combination of pump and media treatment had a significant effect on the root volume parameter (mm) on the growth of lettuce (*Lactusa sativa* L). 4). The best result, namely the consumption weight, was achieved in the P3S2 treatment (Combination of treatment using a pump and cocopeat media) with a value of 119.33 g.

KEYWORD

air pump, lettuce, planting medium, water pump

INFORMATION

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1. INTRODUCTION

Lettuce (*Lactusa sativa* L.) is one of the vegetable commodities that can be grown in tropical and subtropical areas. The increase in population and the level of public awareness in Indonesia to meet the nutritional needs of vegetables has an impact on increasing the demand for lettuce. 100 grams of lettuce contained 15 calories of energy, 2.87 grams of carbohydrates, 1.36 grams of protein, and 0.15 grams of fat (Rahayu, 2018). Hydroponics is a plant cultivation technique using media other than soil which is fed with a nutrient solution. Hydroponic water culture is one way to grow crops without using soil media or nutrient solutions. Several kinds of hydroponic systems can be used, namely the NFT system, DFT, and Floating Raft.

The main principle of the NFT hydroponic system is a thin, circulating nutrient solution, meaning that water and nutrients are used repeatedly after passing through the plant so that it is more economical than other systems and can minimize the occurrence of deposits (Sesanti and User, 2016). The DFT hydroponic system is one method that uses a closed flow system, which circulates the nutrient solution repeatedly for 24 hours in a closed circuit (Roidah, 2014). The difference with the NFT system was that the installation is flat with a height of 3-6 cm. The floating raft hydroponic system is one of the hydroponic methods in which plants are grown on the surface of a nutrient solution in a tub or pond using Styrofoam as plant support.

According to Herwibowo and Budiana (2015), floating raft hydroponics has advantages such as plants getting a continuous supply of water and nutrients, saving water and nutrients more, and simplifying maintenance because there is no need for watering. Furthermore, floating raft hydroponics is a hydroponic method that is relatively easy because it does not require a lot of money and does not need more skills to assemble the system (Sutanto, 2015).

The floating raft hydroponic system is the simplest hydroponic system. The floating raft hydroponic system makes plant roots continuously get nutrients and minerals that cause plants to grow and develop properly (Umar *et al.*, 2016). The problems contained in the system must be solved to produce a more optimal system performance. One of them is using appropriate soil replacement media and a water pump (aquarium pump) and an air pump (aerator) to circulate nutrients and create air bubbles. The purpose of using water pumps (aquarium pumps) and air pumps (aerators) is so that nutrients are evenly distributed in nutrient water, both in planting ponds and in nutrient reservoirs, so that plant growth can be evenly distributed. The study's findings indicate that lettuce (Panorama, Grand Rapids, red lettuce, minetto, Rolorosa), caissim (Tosakan), pakchoy (Writetropical type), kailan (BBT 35), kangkung (Bangkok LP1), and celery are among the plant species that are suitable for cultivation using the floating system hydroponic technology (THST) or floating raft hydroponic system (Amigo).

2. METHODOLOGY

The research was conducted in March-June 2022 at the Green House FP UTP. This study uses a factorial method with a basic design of a trial Completely Randomized Design (CRD) with two treatment factors and three replications.

The first factor is the use of water pumps and air pumps/aerators (P) with 4 (four) levels of treatment, namely:

P0 = Without water pump (aquarium pump) and air pump (aerator)
P1 = By only using a water pump (aquarium pump)

P2 = By using only the air pump (aerator)
P3 = combination of using a water pump (aquarium pump) and an air pump (aerator)

The second factor is the use of soil substitute planting media (S) with 3 (three) levels of treatment, namely:

S1 = Rockwool
S2 = Cocopeat
S3 = Moss/moss

So that obtained 12 treatment combinations, namely P0S1; P0S2; P0S3; P1S1; P1S2; P1S3; P2S1; P2S2; P2S3; P3S1; P3S2; P3S3. It is carried out with 3 (three) repetitions.

3. RESULTS AND DISCUSSION

The analysis of variance showed that the use of pumps significantly affected the research parameters: plant height, stem diameter, number of leaves, leaf width, fresh plant weight, and plant dry weight (aerator) on lettuce plant growth is presented in Table 1.

Table 1. The effects of a water pump (aquarium) and air pump (aerator) on lettuce growth

No	Parameter	Pump (P)	Medium (S)	Interaction (P x S)	Value			
					Highest		Lowest	
1.	Plant Height (cm)	**	ns	ns	18.61	(P2S3)	12.89	(P0S3)
2.	Rod Diameter (cm)	**	ns	ns	0.87	(P3S1)	0.58	(P1S1)
3.	Number of Leaves (strands)	**	ns	ns	32.00	(P3S3)	24.00	(P0S2)
4.	Leaf Width (cm)	**	ns	ns	8.11	(P3S2)	6.76	(P0S1)
5.	Plant Fresh Weight (g)	**	ns	ns	285.60	(P3S1)	126.33	(P1S2)
6.	Plant Dry Weight (g)	**	ns	ns	6.67	(P2S3)	1.88	(P1S1)
7.	Consumption Weight (g)	**	ns	ns	119.33	(P3S2)	44.00	(P0S3)
8.	Number of Leaf Consumption (strands)	**	ns	ns	38.00	(P3S1)	23.00	(P1S3)
9.	Root Length(cm)	**	ns	ns	35.33	(P3S3)	5.83	(P0S3)
10.	Root Fresh Weight (g)	ns	**	ns	73.67	(P3S1)	26.67	(P1S3)
11.	Root Dry Weight (g)	ns	ns	ns	3.48	(P2S2)	1.02	(P2S2)
12.	Root Volume (mm)	ns	*	*	85.00	(P3S3)	25.00	(P2S2)
13.	Water content (%)	ns	ns	ns	0.99	(P3S1)	0.96	(P0S3)

Note: significant level: **= 95%; *= 90%, ns= not significant

The results of the analysis of variance of the combination of pump and media use showed that the combination of pump and media use significantly affected root volume parameters with the highest value of 85 mm in treatment (P3S3) and the lowest value with a value of 25 mm in treatment (P2S2).

The analysis of variance in media use showed that the use of media had a very significant effect on the fresh weight parameters. But it had no significant effect on plant height, stem diameter, number of leaves, leaf width, fresh plant weight, plant dry weight, consumption weight, number of leaves consumed, root length, dry root weight and moisture content.

Based on the results of analysis of variance in the Use of water pumps (aquarium pumps), air pumps (aerators) and the combination of the Use of water pumps (aquarium pumps), air pumps (aerators) and the use of media in detail are as follows: the Combination of the Use of a water pump (aquarium pump) and an air pump (aerator) (P3) showed a very significant effect on the stem diameter parameters with the highest value of 0.87 cm (P3S1) and the lowest value of 0.58 cm (P1S1), the number of leaves with the highest value of 32 strands (P3S3) and

the lowest value of 24 strands (P0S2), leaf width with the highest value of 8.11 cm (P3S2) and the lowest value of 6.76 cm (P0S1), plant fresh weight with the highest value of 285.60 g (P3S1) and the lowest value of 126.33 g (P1S2), the weight of consumption with the highest value of 119.33 g (P3S2) and the lowest value of 44.00 g (P0S3), the number of consumption leaves with a value of the highest before sar 38 strands (P3S1) and the lowest value of 23 strands (P1S3) and root length with the highest value of 35.33 cm (P3S3) and the lowest value of 5.83 (P0S3). However, there was no significant difference in the parameters of fresh root weight, root volume and moisture content

Table 2. Duncan's Multiple Range Test (DMRT) level 5% Treatment of parameters Lettuce growth

Treatment	Parameter												
	Height (cm)	Stem Diameter (cm)	Leaf Number (Strand)	Leaf Width (cm)	Fresh weight (g)	Dry Weight (g)	Consumption weight (g)	Number of Leaf Consumption (strands)	Root Length (cm)	Fresh Weight of Root (g)	Dry Weight of Root (g)	Root Volume (mm)	Moisture Content (%)
Pump use													
P0	14.64b	0.79a	27c	7.27c	154.41c	3.81c	70.44b	30b	8.37c	48.48	1.50	53.70	0.97
P1	14.58b	0.65b	25d	7.80a	139.33c	3.22d	61.00b	26c	22.13b	42.52	1.65	44.44	0.98
P2	16.76a	0.80a	28b	7.54b	247.19b	5.19a	91.52a	31b	26.74a	53.26	1.98	41.67	0.98
P3	16.14a	0.81a	31a	7.52b	267.93a	4.67b	96.78a	35a	26.19a	55.26	1.92	53.89	0.97
Medium Use													
S1	15.42	0.75	28	7.48	208.69	3.97	77.16	32	20.59	57.94a	1.79	46.53	0.98
S2	15.17	0.77	28	7.46	207.77	4.42	83.58	30	20.68	50.72a	1.97	56.39	0.98
S3	16	0.77	28	7.65	190.17	4.26	79.05	30	21.29	40.97b	1.54	42.36	0.97
Combination Treatment of Pump and Medium Use (P x S)													
P0S1	14,25	0,75	27	7,12	153,55	3,61	57,44	30,33	8,44	61,33	1,5	61,11a	0,97
P0S2	15,13	0,8	26	7,07	174,22	4,26	87,55	30,44	8,72	44,55	1,54	58,33ab	0,97
P0S3	14,54	0,81	27	7,59	135,44	3,55	66,33	30,11	7,94	39,55	1,45	41,67cd	0,97
P1S1	14,68	0,62	25	7,76	145,55	2,81	66,22	26,77	24,16	46,55	1,32	50,00bc	0,98
P1S2	13,77	0,66	25	7,76	138,66	3,7	54,11	25,55	20,88	49,55	2,16	47,22c	0,97
P1S3	15,28	0,65	25	7,87	133,77	3,13	62,66	25,77	21,33	31,44	1,47	36,11de	0,97
P2S1	16,6	0,81	28	7,48	264,77	5,34	97,11	32,44	25,77	59,33	2,27	33,33de	0,97
P2S2	16,07	0,8	28	7,49	239,55	4,87	90	30,55	28,44	55,66	2,05	61,11a	0,98
P2S3	17,61	0,81	27	7,76	237,22	5,33	87,44	30,77	26	44,77	1,63	30,56e	0,98
P3S1	16,15	0,81	31	7,53	270,86	4,11	87,88	36,66	24	64,55	2,04	41,67cd	0,97
P3S2	15,69	0,81	31	7,52	278,67	4,86	102,66	34,55	24,66	53,11	2,11	58,89ab	0,98
P3S3	16,58	0,81	30	7,5	254,25	5,02	99,77	35	29,88	48,11	1,6	61,11a	0,97

Note : The treatment followed by the same letter in the same column showed no significant difference in the 5% DMRT follow-up test.

The treatment using an air pump (aerator) showed a very significantly different effect on plant height parameters with the highest value of 18.61 cm (P2S3) and the lowest value of 12.89 cm (P0S3) and planted dry weight with the highest value of 6.67 g. (P2S3) and not significantly different in root dry weight parameters.

The use of substitute media/substrate (S) in the recapitulation of variance showed a very significant effect on the fresh weight parameters of roots, with the highest value of 73.67 g (P3S1) and the lowest value of 26.67 g (P1S3), and showed a significantly different effect on root volume parameters with the highest value of 85 mm (P3S3) and the lowest value of 25 mm (P2S2). However, there were no significant differences in plant height, stem diameter,

number of leaves, leaf width, fresh plant weight, plant dry weight, number of leaves consumed, root length, dry root weight and moisture content.

The interaction of the Combination of treatments using water pumps and air pumps and the Use of substrate media (PxS) showed a significantly different effect on root volume parameters, with the highest value of 85 mm (P3S3) and the lowest value of 25 mm (P2S2). However, there were no significant differences in the parameters of plant height, stem diameter, number of leaves, leaf width, fresh plant weight, plant dry weight, consumption weight, number of leaves consumed, root length, dry root weight and moisture content.

Lettuce plant growth was observed from the parameters of plant height, stem diameter, number of leaves, leaf width, fresh plant weight, plant dry weight, consumption weight, number of leaves consumed, root length, fresh root weight, and root dry weight, root volume and water content. The Duncan's Multiple Range (DMRT) test at 5% level was carried out, presented in Table 2.

In plant height parameters, treatment P2 (with the use of an air pump (aerator)) (16.76 cm) and treatment P3 (significantly different compared to treatment P1 (with the use of a water pump (aquarium pump)) (14.58 cm) and treatment P0 (without the use of a pump) but not significantly different from the treatment of P3 (with a combination of the use of a water pump (aquarium pump) and an air pump (aerator)) (16.14 cm). This indicates that using a water pump (aquarium pump) and Air pumps (aerators) affects plant height growth because nutrient circulation can occur with a pump. In addition, using a water pump (aquarium pump) and an air pump (aerator) has a real effect because, apart from circulating nutrients, there is also a need for oxygen. For plants are met. The results of this study are in line with Susila (2009), which states that the success of a water culture system is influenced by several factors that are directly related to plant roots, including (1) aeration in the root zone, (2) root conditions, and (3) a plant support system that allows plants to grow upright.

In stem diameter parameters, treatment P3 (with a combination of the use of a water pump (aquarium pump) and air pump (aerator)) (0.81 cm) was significantly different compared to P1 treatment (with the use of a water pump (aquarium pump)) (0.65 cm) and P0 treatment (without the use of a pump) (0.79 cm). But not significantly different from the P2 treatment (with the use of an air pump (aerator)) (0.80 cm). This shows that the combination treatment with the use of a water pump (aquarium pump) and an air pump (aerator) has a significant effect on stem growth as indicated by the size of the stem diameter created because oxygen needs are met for the process of plant growth.

In the number of leaves, treatment P3 (with a combination of the use of a water pump (aquarium pump) and air pump (aerator)) (31 strands) was significantly different compared to treatment P2 (with the use of an air pump (aerator)) (28 pieces), treatment P1 (with the use of a water pump (aquarium pump)) (25 pieces) and P0 treatment (without the use of a water pump (aquarium pump) and air pump (aerator)) (27 pieces).

In leaf width parameters, treatment P1 (with the use of a water pump (aquarium pump)) (7.80 cm) was significantly different from P3 treatment (with a combination of using a water pump (aquarium pump) and air pump (aerator)) (7.52 cm). P2 treatment (with the use of an air pump (aerator)) (7.54 cm) and P0 treatment (without the use of a water pump (aquarium pump) and air pump (aerator)) (7.27 cm).

The results showed that the P3 treatment (with a combination of the use of a water pump (aquarium pump) and an air pump (aerator)) significantly affected the growth parameters of stem diameter (0.81 cm) and the number of leaves (31 leaves).

In terms of fresh plant weight, treatment P3 (with a combination of the use of a water pump (aquarium pump) and air pump (aerator)) (267.9 g) was significantly different compared to P2 treatment (247, 19 g), and treatment P2 (139.33 g) were significantly different from treatment P1. However, there was no significant difference between P1 treatment (only with the Use of a water pump (aquarium pump)) (139.33 g) against P0 treatment (without the use of a pump) (154.41 g).

While the P3 treatment (Combination of the Use of a water pump (aquarium pump) and air pump (aerator)) (267.93 g) was significantly different from the P1 treatment (only with the use of a water pump (aquarium pump)) (139.33 g) and to P0 treatment (without the use of a water pump (aquarium pump) and air pump (aerator)) (154.41 g), this shows that the Combination of the Use of a water pump (aquarium pump) and an air pump (aerator) has an effect on the yield of lettuce, namely the fresh weight of the plant. Because the circulation of nutrients also meets plants' need for oxygen, in addition to circulating nutrients, the need for oxygen for plants is met. The results of this study are in line with Susila (2009), which states that the success of a water culture system is influenced by several factors that are directly related to plant roots, including (1) aeration in the root zone, (2) root conditions, and (3) plant support systems, which allows the plant to grow upright.

In the dry weight parameter of plants, treatment P2 (with the use of an air pump (aerator)) (5.19 g) was significantly different from treatment P3 (with a combination of the use of a water pump (aquarium pump) and an air pump (aerator)) (4.67 g) and P0 treatment (without the use of a water pump (aquarium pump) and air pump (aerator)) (3.81 g). and treatment P2 (with the use of an air pump (aerator)) (5.19 g) was very significantly different from treatment P0 (without the use of a water pump (water pump) and air pump (aerator)) (3.81 g) and treatment P1 (with the use of a water pump (aquarium pump)) (3.22 g). This shows that the treatment using an air pump (aerator) plays a very important role in meeting plants' oxygen needs. The results of this study are in line with Susila (2009), which states that the success of a water culture system is influenced by several factors that are directly related to plant roots, including (1) aeration in the root zone, (2) root conditions, and (3) plant support systems, which allows the plant to grow upright.

Based on the Duncan's Multiple Range Test (DMRT) further test with a level of 5%, that on the parameter of Consumption Weight. The P3 treatment (Combination of the Use of a water pump (aquarium pump) and air pump (aerator)) (96.78 g) to the P2 treatment (with the use of an air pump (aerator)) (91.52 g) showed no significantly different results. Likewise, treatment P1 (Use of water pump (aquarium pump)) (61.00 g) to treatment P0 (without the use of water pump (aquarium pump) and air pump (aerator)) (70.44 g) showed no different results. Real. While the P3 treatment (Combination of the Use of a water pump (aquarium pump) and air pump (aerator)) and P2 treatment (the use of an air pump (aerator)) showed very significantly different results from the P1 treatment (the use of a water pump (aquarium pump)) and P0 treatment. (without the use of a water pump (aquarium pump) and air pump (aerator)).

The results of this study are in line with Susila (2009), which states that the succFess of a water culture system is influenced by several factors that are directly related to plant roots, including (1) aeration in the root zone, (2) root conditions, and (3) plant support systems, which allows the plant to grow upright. Oxygen needs are met for the process of plant growth.

In addition, it is also in line with previous research (Kurniasih, 2011). Continuous use of aerators tends to increase the growth and yield of red spinach, kale and lettuce. And the use of aerators tends to increase the growth and yield of red spinach, kale and lettuce in the FHS and DFT hydroponic systems.

In the parameters of the number of leaves consumption, treatment P3 (with a combination of the use of a water pump (aquarium pump) and air pump (aerator)) (35 pieces) was very significantly different from treatment P1 (with the use of a water pump (aquarium pump)) (26 pieces) and P0 treatment (without the use of a water pump (aquarium pump) and air pump (aerator)) (30 strands), P2 treatment (with the use of an air pump (aerator)) (31 strands) and P0 treatment (without the use of a water pump (aquarium pump) and air pump (aerator)) (30 pieces) in the Duncan's Multiple Range Test (DMRT) follow-up test at 5% level, and the results were not significantly different.

In the parameter of root length, treatment P3 (Combination of the Use of a water pump (aquarium) and air pump (aerator)) (26.19 cm) showed very significantly different results from treatment P0 (without the use of a water pump (aquarium pump) and air pump (aquarium pump). aerator)) (8.37 cm). Treatment P2 (Use of air pump (aerator)) (26.74 cm) showed significantly different results from treatment P1 (Use of water pump (aquarium pump)) (22.13 cm). This is also in line with Dharmayanti *et al.* (2012) research. Aeration treatment in lettuce cultivation affected changes in dissolved oxygen value, number of leaves, root length, crown fresh weight, dry canopy weight and leaf color.

Overall, the results of this study indicate that the P3 treatment (Combination of the Use of a water pump (aquarium pump) and an air pump (aerator)) has a very significant effect on the parameters of fresh plant weight (267.93 g), consumption weight 96.78 g). , the number of leaves consumption (35 pieces)

The use of soil replacement media on root fresh weight parameters showed that the S1 (Rockwool) (57.94 g) and S2 (cocopeat) (50.72 g) treatments were very significantly different from the S3 (moss) treatment (40.97). While the S1 (Rockwool) treatment against the S2 (cocopeat) treatment showed no significant difference. The results of this study align with Susilawati (2019) that as a planting medium, Rockwell can hold large amounts of water and air (oxygen for aeration), which are needed for root growth and nutrient absorption in the hydroponic method. Rockwool's natural fiber structure is also very good for supporting plant stems and roots to stand stably.

4. CONCLUSION

The pump treatment had a very significant effect on the parameters of plant height (cm), stem diameter (cm), number of leaves (strands), leaf width (cm), fresh plant weight (g), plant dry weight (g), consumption weight (g).), number of leaf consumption (strands), and root length (cm). and did not affect the parameters of fresh root weight (g), root dry weight (g), root volume (mm), and water content (%). The media treatment had a very significant effect on the parameters of fresh root weight (g), significantly affected the parameters of root volume (mm) and did not affect the parameters of plant height (cm), stem diameter (g), number of leaves (strands), leaf width (cm).), fresh plant weight (g), plant dry weight (g), consumption weight (g), number of leaves consumed (strands), root length (cm), root dry weight (g) and moisture content (%).

The combination treatment using pump and media did not affect the parameters of plant height (cm), stem diameter (g), number of leaves (strands), leaf width (cm), fresh plant weight (g), plant dry weight (g), consumption weight. (g), the number of leaves consumed (strands), root length (cm), fresh root weight (g), root dry weight (g) and moisture content (%). The best result is the weight of consumption in the P3S2 treatment (Combination of treatment using pump and cocopeat media) with a value of 102.66 g, and the lowest result in the P1S2 treatment (Combination of treatment using pump and cocopeat media) with a value of 54.11 g.

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