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(RESEARCH ARTICLE)

Stability test and identification of factors causing inconsistencies in the quantity and quality of lettuce yield (*Lactuca sativa* L.) at different planting times in NFT system hydroponics

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Abstract

Lettuce is a vegetable plant that belongs to the *Asteraceae* or *Compositae* family and has great potential especially in the agricultural industry. agricultural land in Indonesia is getting narrower resulting in not maximizing agricultural yields. To overcome this, cultivation techniques that do not require large areas are needed, one of which is NFT hydroponics. In the process, there are obstacles that arise, namely the instability or inconsistency of the quality and quantity of lettuce production in each planting period. the factors that cause the instability of lettuce crop yields are due to changes in microclimate conditions and cultivation techniques that are not in accordance with the SOP. This study used a 1-factor Randomized Block Design (RAL) with 10 replications. The factor tested as treatment was different planting time (W) consisting of 3 levels, namely: Ws (July-August), Wd (August-September), Wt (September-October). From the research results, the July-August period can provide the best results with environmental conditions that are in accordance with the requirements for lettuce growth with a temperature of 25-33^{o}C and 78% humidity. As well as cultivation techniques in accordance with the SOP that is run.

Keywords: Lettuce; Planting Time; Hydroponics; Nurient Film System

1. Introduction

Lettuce (*Lactuca sativa L*) is a vegetable crop that originated in Western Asia and spread to temperate countries. Lettuce is a vegetable plant that belongs to the *Asteraceae* or *Compositae* family. Lettuce plants are usually utilised as vegetables, and are widely cultivated because they have abundant nutritional and vitamin content and have high economic value. Lettuce is one of the commodities in horticulture that has prospects and commercialise [1].

Lettuce has considerable market opportunities when viewed from the production and export of lettuce crops in 2019 [3], both to meet the needs of domestic and international markets. A common problem is that the demand for food is high, but agricultural land in Indonesia is getting smaller. This is caused by several factors, one of which is land conversion.

Hydroponics is one of the alternatives that can be used to increase plant productivity, especially in small spaces. One of the hydroponic cultivation systems that can be used is Nutrient Film Technique (NFT). Cultivation using this hydroponic system has been widely applied in several large companies in Indonesia, one of which is PT Kebun Sayur Surabaya. NFT lettuce hydroponic farming activities at PT Kebun Sayur Surabaya have obstacles in production. The constraints faced are instability or inconsistency in the quality and quantity of lettuce production in each planting period.

The alleged factors causing the instability of lettuce yields are due to changes in microclimatic conditions and cultivation that is not in accordance (inconsistent) with the usual SOPs. The July-August period can provide the best results with

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environmental conditions that are in accordance with the requirements and SOPs that are carried out. Plants need microclimate conditions that are in accordance with the planting conditions to get optimal plant growth and plant yields.

2. Materials and Methods

The research was conducted from July to October 2024, located in the greenhouse of PJ Fresh Hydroponics, a partner of PT Surabaya Vegetable Garden with coordinates 7°56'28.9 "S 112°34'08.6 "E and an altitude of ± 700 masl. Laboratory tests were carried out at the Agronomy and Horticulture Lab, Faculty of Agriculture, Udayana University, Sudirman campus, Denpasar.

The tools needed are PVC pipes with a diameter of 4 inches, pipe supports, water pumps, water hoses, nutrient reservoirs, netpots, vectors, analytical scales, colour charts, filter paper, funnels, ovens, *Rhizo Vision, explorer*, *Chlorophyll Meter SPAD-502,* and stationery. The materials used in this study were lettuce seeds, AB mix kryptonium nutrients, rockwool, clean water. The research used a 1-factor Randomised Block Design (CRD) with 10 replications. The factor tested as treatment was different planting time (W) consisting of 3 levels, namely: Ws (First planting time July-August 2024), Wd (Second planting time August-September 2024), Wt (Third planting time September-October 2024).

2.1. Seed sowing

Seed sowing uses rockwool one seed per planting hole, after which the seedlings are put in a netpot that has been placed in the gutter/gully and make sure the rockwool touches the bottom of the netpot so that it is flowing with nutrients. The nutrient used is AB Mix Kriptonium found and concocted by PT Kebuh Sayur Surabaya with a package of concentration, pH, and electrical conductivity of the solution according to the usual procedures carried out by PT Kebuh Sayur Surabaya.

2.2. Planting seedlings in an NFT hydroponic system

NFT (Nutrient Film Technique) system used in this study is a system in hydroponics using 24-hour circulation of AB Mix Kriptonium nutrients with a thin film-like flow, using electricity to drain nutrients. The NFT system uses a gutter/gully as an installation with a slope of 1 to 5 degrees, functioning to facilitate the flow of nutrients.

The PJ Fresh Hydroponic System has a reservoir capacity of 1500 liters which contains Hydroponic Nutrients and is flowed to each gutter with the help of pumps and aerators as stirrers. The table used in this hydroponics can accommodate 5-10 gutters and each gutter consists of 40-50 planting holes with a distance of 20 cm between holes. Before transplanting, the gutters are first cleaned using HCI solution to ensure that the scale in the gutters is gone, and to minimize flow inhibition and scale does not enter the nutrient reservoir.

2.3. Application of nutrient ab mix

During the growth period, lettuce needs to be monitored, especially the level of nutrients contained in the reservoir. Regular checks are carried out to ensure that nutritional needs are met every day. The first step is to dissolve the nutrients so that they become nutrients in concentrated liquid form. For AB Mix Kryptonium nutrition requires 350 ml of concentrated mix A and 350 concentrated mix B to increase 0.1 EC. The nutrient solution that has reached 1.5-1.6 EC is then flowed into each gutter for 24 hours until the plants are harvested. Hydroponic farming absolutely requires fertiliser as a source of nutrients for plants. Fertiliser is given in the form of a solution that contains macro and micro elements in it [4].

2.4. Harvesting lettuce

hydroponic lettuce planting research with NFT (Nutrient Film Technique) is usually done when the plants have reached the optimal harvesting age. For lettuce, the optimal harvest age is about 4-6 weeks after planting. At harvest time, the lettuce plants that are still in the gutters are transported, then separated between the roots and the netpot. After that, sorting of small and large lettuce is carried out, then the outer leaves are sorted, and leaves that are not suitable for consumption such as yellow leaf edges and caterpillar droppings.

2.5. Observation Variables

2.5.1. Plant height (cm)

calculated weekly from 1 week after planting (MST) until the day before harvest using a ruler.

2.5.2. Number of leaves (pieces)

counted weekly from 1 MST until the day before harvest using a counter.

2.5.3. Leaf area (cm)

measured at harvest time using the formula :

$$L = PxLxK$$

Description:
L : Leaf area
P : Leaf length
K : Constant

2.5.4. Leaf thickness (mm)

Measured at harvest time by measuring the thickness of each leaf at 5 points using a caliper and then averaged.

2.5.5. Leaf colour

Measured at harvest using a leaf colour chart and then compared to the colour of the leaves.

2.5.6. Leaf chlorophyll content (SPAD)

Leaf chlorophyll was observed twice at week 2 and 4 weeks after planting for each planting time period, measured with a *Chlorophyll Meter SPAD-502*. Leaf chlorophyll measurements were made on leaf samples from the bottom, middle and top, then each leaf was measured at 5 points. By pressing the "average" button on the tool, the average chlorophyll content of the leaves was obtained.

2.5.7. Relative water content (RWC) of leaves (%)

Measurement of the Relative Water Content (RWC) of leaves was carried out twice for each planting time. For each RWC measurement, leaf samples from each plant were required from the top, middle, and bottom leaves, by cutting a certain amount of area from the leaves. After the leaf samples were picked, they were immediately wrapped in airtight plastic and put into a thermos filled with ice and taken to the laboratory. In the laboratory, from the leaf sample sheet, 20 pieces of leaves with a size of 1 x 1 cm each were taken, then weighed for fresh weight. After weighing, it was put into a cup filled with water and irradiated with 40 watt fluorescent light at room temperature for 5 hours. After it was removed, the water that was still attached was carefully cleaned using a tissue and then weighed the turgid weight. After that, the leaf pieces were oven dried at 70^0 C for 24 hours and then weighed. RWC value (%) was calculated by the formula:

$$\text{RWC Value } \% = \frac{\text{Turgid weight } - \text{Dry Weight}}{\text{Fresh weight} - \text{Dry Weight}} \times 100$$

2.5.8. Leaf N, P and K nutrient content (%).

Leaf N, P and K contents were analysed in the laboratory using leaf samples from the bottom, middle and top. Samples were taken at 2 and 4 weeks after planting, then composited. Total N content was measured by the Kjehdahl method, while P and K nutrient content was measured by the Olsen and Bray methods.

2.5.9. Light intensity in the greenhouse (lux)

Measured at several growth phases using a lux meter and then averaged.

2.5.10. Temperature (^{0} C) and relative air humidity (%) in the greenhouse

Measured at several growth phases using a hygrometer then averaged

3. Results and Discussion

The treatment of planting time has a significant effect on the fresh weight of baby roamine lettuce plants planting time one (Ws) with the highest value of 220.45 g. (Table 1) Nutrients play an important role as a source of energy for plants so that nutrients must be available and sufficient because it greatly affects the biomass of a plant. Total fresh weight of plants is influenced by plant biomass including plant height, number of leaves, thickness and area of plant leaves. In leaf vegetable commodities, the number of leaves will affect the fresh weight of the crown. The more the number of leaves will show a higher crown fresh weight [6].

Based on the results of the analysis of the smallest real weight (BNT) shows that the treatment of planting time has a real effect on plant height. the average results of plant height can be seen in the table. 1. The highest results of plant height variables are found at planting time one (Ws) with a value of 18.55 cm. The average temperature obtained by planting time one in the July-August period is 29^{o} and humidity is around 63%. The maximum humidity obtained by measuring the tool every day is 99%. Lettuce will be optimal in the air temperature range of 25 ° C to 28 ° C and humidity ranges from 65% to 78% [7]. Through research by Agmey Wijaya stated that lettuce plants require environmental conditions with a temperature range of 15-25 ° C, air humidity around 81-90% with an altitude of 500-2000 masl [8].

Another indicator that can determine that plants experience growth is the number of leaves. The results of the least significant difference test (BNT) of planting time treatment on the number of leaves of plants presented in Table 1. shows that planting time has a significant effect on the number of leaves. Planting time one (ws) has a different value from other planting times, with the value of Ws obtained being 18.95. Leaves have an important role in growth, because the formation of energy in plants is found in the leaf organ through the process of photosynthesis. Measurement of the number of leaves is done by counting leaves with characteristics, still fresh, fully open and still attached to the plant stem, not leaves that are still buds or leaves that are still withering [9].

Leaf area with planting time treatment had a very significant effect between planting time one (Ws) with a value of 205.97 (Table 1). The larger the leaves of the plant, the greater the acceptance of sunlight obtained [10]. The longer the lettuce leaves, the more chlorophyll content that plays an important role in the photosynthesis process [11]. The amount of chlorophyll will be proportional to the amount of photosynthesis [10]. If the chlorophyll content in the leaves more and more then the results of the photosynthesis process will increase [12].

Table 1 Effect of planting time on fresh weight, plant height, number of leaves, leaf area, and chlorophyll variables

Treatment	Fresh Weight (gr)	Plant Height (cm)	Number of Leaves (blade)	Leaf area (cm)	Leaf Chlorophyll (SPAD)
Planting Time					
Ws	220,45 a	18,55 a	18,95 a	205,97 a	36,45 a
Wd	135,10 b	17,11 b	18,90 a	151,47 c	30,64 c
Wt	126,25 c	16,79 b	16,65 b	171,35 b	33,76 b
BNT 5%	7.41	0.19	0.27	8.29	0,57

Observations of leaf colour and leaf thickness were made as supporting data for the analysis of chlorophyll content of green lettuce plants. The results of variance analysis and BNT analysis showed that the thickness of the leaves in the treatment of planting time had a very significant effect between other planting times. The highest leaf thickness in the treatment of planting time one (Ws) with a value of 0.24 mm. leaf thickness can affect chlorophyll content. Thin leaf morphology is generally easy to wither when picked so that chlorophyll is easily degraded. The analysis showed that the highest leaf colour was in Ws with a value of 3.24. The substance that causes the leaves to be green in colour. Chlorophyll affects the absorption of the colour spectrum of light that hits the leaves, so the leaves look green. A study said that the greener the leaf colour, the higher the chlorophyll content [13].

Light intensity in the treatment of planting time has a very significant effect between planting time one (WS), planting time two (WD), and planting time three (WT) with a value of 26.84%, 25.93%, 33.41% respectively. The intensity of sunlight needed for lettuce plant growth is 200-400 footcandles or 2152.78-4305.56 lux [14].

Table 2 Effect of planting time on variables of light intensity (lux), relative water content (RWC), vit c, and leaf colour

Treatment	Leaf Thickness (mm)	Leaf colour	Light Intensity (lux)	Relative water content (RWC)	Vit C (ml)
Planting Time					
Ws	0,24 a	3,24 a	26,84 b	0,82 a	36,96 a
Wd	0,21 b	3,01 b	25,93 c	0,81 a	33,44 a
Wt	0,19 c	2,91 c	33,41 a	0,83 a	35,20 a
BNT 5%	0.02	0.07	4.64	0.07	10,68

Notes Numbers followed by the same letter are not significantly different at the 5%

The microclimate at the time of the study needs to be considered to support optimal plant growth and production. Microclimates such as air temperature, air humidity were measured every day and averaged. The temperature was recorded in the morning around 08:00-09:00 WIB. The microclimate at the research location in the PJ Fresh Hydroponic Greenhouse shows that the average air temperature for each planting time period can be seen in Figure 1. The lowest air temperature is 24^{o} C and the highest is 33 ^{o} C. The highest air humidity is around 99%, at the highest humidity is around 99%. The highest air humidity is around 99%, at planting time period one the average humidity produced is 77% (Figure 2). This is in accordance with the statement of Jervis Rowe and Compton Paul (2014) that according to him, good humidity for lettuce plants is (70-80) % [15], while other sources say, the growth of 'Grand Rapid' lettuce will be optimal in the range of air temperature (25-26) °C and humidity ranging from (76-77) % [7].

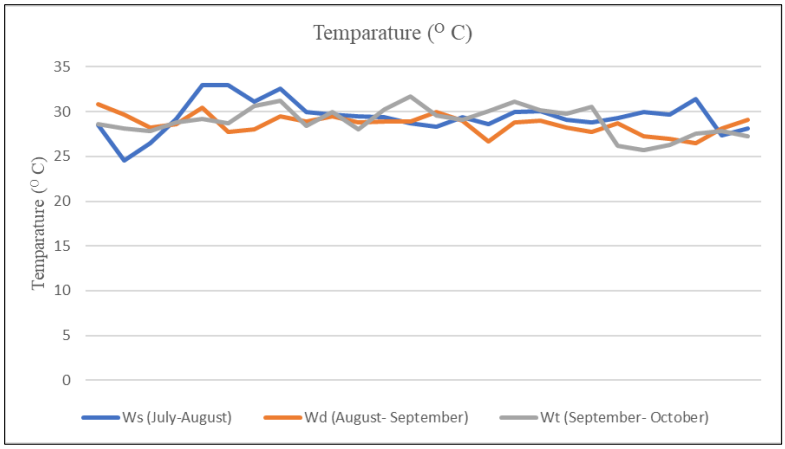

Figure 1 Air temperature for the periods Ws (July-August), Wd (August-September), Wt (September-October)

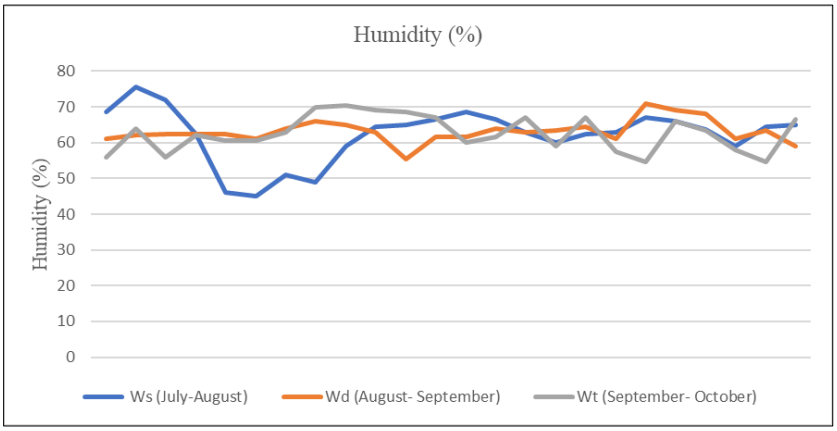

Figure 2 Air humidity period Ws (July-August), Wd (August-September), Wt (September-October

The results of microclimate measurements show that air temperature, air humidity, and sunlight intensity fall within the optimum range of lettuce growth so that it can be said that lettuce cultivation, especially in the first planting time period, is in accordance with the growing requirements of lettuce plants.

4. Conclusion

The treatment of planting time one (ws) in the July-August period got the best results among planting time two (Wd) and planting time three (Wt), because it was supported by environmental factors that were in accordance with the optimum growth requirements with a temperature of 25-33^{o}C and 78% humidity and cultivation in accordance with the SOPs that were carried out. planting time treatment significantly affected almost all variables observed except vit c and relative water content (RWC).

Compliance with ethical standards

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Disclosure of conflict of interest

There is no conflict of interest in the research.

References

[1] Cahyono, B. Techniques and Strategies for Cultivating Green Lettuce (PaiTsai). Yogyakarta: Nusatama Library Foundation; 2014 [Indonesian]

[2] Central Bureau of Statistics. Lettuce Crop Production in Indonesia 2014-2017. Jakarta Pusat: Central Bureau of Statistics; 2017 [Indonesian]

[3] Central Bureau of Statistics. Vegetable Import and Export Volume in 2019. Centre for Agricultural Data and Information System; 2019 [Indonesian]

[4] Rizal, S. The effect of nutrients on the growth of pakcoy mustard plants (Brasicca rapa L.) grown hydroponically. Sainmatika. June 2017;14(1), 38-44. [Indonesian]

[5] Roidah, SI. Land utilisation using hydroponic system. J. Univ. Tulungagung Bonorowo. June 2015;1(2): 43-50. [Indonesian]

[6] Darwin HP. Effect of liquid organic fertiliser on growth and production of leaf vegetables kale, spinach and caisin. Procid. Sem. Nas. November 2012; 1(3), 154-160. [Indonesian]

[7] Darmawan IA. Effect of Topoclimate on production and Quality of Lettuce (Lactuca sativa L.), Thesis, Yogyakarta: Gadjah Mada University; 1997. [Indonesian]

[8] Agmey W, Sisca F. Growth and yield of lettuce (Lactuca sativa L.) in axis system hydroponic method with different shade density and nutrient concentration. Journal of Plant Production. October 2022; 10(10); 541-549. [Indonesian]

[9] Sari DN. Mini hydroponics as practical media for lettuce (Lactuca sativa L) growth with different concentrations of gandasil B. Thesis. Pontianak: Tanjungpura University; 2014. [Indonesian]

[10] Miharja NDS, Purnomo SS, Surjana T. Effect of combined fermentation of tofu liquid waste and npk on the growth and yield of lettuce (Lactuca sativa L.) Grand Rapids variety in verticulture system. Scientific Journal of Wahana Pendidikan. December 2021; 7 (8): 101-108. [Indonesian]

[11] Rofiyana A, Laksono RA, Syah B. Growth and yield of baby kailan (Brassica oleraceae var. Acephala) cultivar new veg gin with aerator activation time and different ec values in floating raft hydroponic system. Scientific Journal of Wahana Pendidikan. December 2021; 7 (8): 289- 299. [Indonesian]

[12] Furoidah N. Effectiveness of using ab mix on the growth of several varieties of mustard greens (Brassica sp.). Proceedings of UNS National Seminar. 2018 2(1): 239-246.

[13] Dharmadewi I, M. Analysis of Chlorophyll Content in Several Types of Green Vegetables as an Alternative Food Supplement Base Material. Journal of Maths and Science Education. 2020; 9 (2). [Indonesian]

[14] Usman, N. Horticultural Area with Greenhouse Concept in Makassar. Thesis. Makassar: State Islamic University of Alauddin Makassar; 2017. [Indonesian]

[15] Rowe, Jerwis. Tropical Greenhouse Growers Manual For The Caribben. The Caribbean Agricultural Research and Development Institute, UWI Campus; 2014. [English]

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