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Study of Several Hydroponics Nutrition for Curly Lettuce (*Lactuca sativa L.*) by Using Sensorized Hydroponics

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Abstract. Hydroponic is a farming method that utilizes water, minerals, and oxygen. This study aims to find out the best nutrition towards growing curly lettuce (Lactuca sativa L.) by using the NFT (nutrient film technique) hydroponic system integrated with sensors to measure EC concentration of nutrients, pH acidity, and RH air humidity. This study also incorporates a grouped randomized design with two nutritional treatment (code P1 and P2), with 20 replication. The results showed that nutrition P1 producing a better variable compared to nutrition P2 in terms of plant length, quantity of leaves, length of root, total mass of fresh plants, total mass of plant crown, total mass of fresh roots, and chlorophyl content.

Introduction

The increasing awareness regarding the importance of a healthy lifestyle triggered an increased demand for vegetables. Curly lettuce is as a horticulture commodity with a prospect and commercial value [3]. Consumers favor curly lettuce because it is consumed raw or in a side dish like salad.

The shift of farmlands into industrial sites has led to a decrease in productive farmland to be utilized by farmers. One of the technologies that can be applied to solve this issue is by utilizing hydroponics [5].

Hydroponics is a cultivation method that uses a growth medium other than soil, hence needing lesser space. Several advantages of hydroponics are efficiency, optimal usage of nutrition and water, better quality, and yield more quantity compared to conventional farming using soil. NFT (nutrient film technique) hydroponics is the best method to cultivate curly lettuce without soil. The NFT method utilizes shallow water flow that circulates micro and macronutrients essential for plants. According to Frasetya et al. (2021), the NFT hydroponic method is the most optimum method for lettuce cultivation [2].

The nutrient solution inside the water flow is vital in supplying water and minerals. The supply of water and minerals becomes the main factor that contributes to the growth and quality of hydroponic plants. The quality of nutrition is controlled based on the EC (electrical conductivity) value and pH [1]. The NFT hydroponic system combined with EC and pH sensors creates ease in supervising the quality of nutrition supplied to plants. This research analyzes two formulations with different micro and macronutrient compositions but with the same electrical conductivity value.

This study aims to distinguish the impacts of different compositions in formulation toward the growth of curly lettuce in the NFT hydroponic system. Formulation P1 containing specific formulations while formulation P2 are store bought commercial formulations.

Materials

This study was conducted in the University of Surabaya's greenhouse and plant laboratory.

The materials used are; curly lettuce seeds and nutrient formulation with codes P1 and P2. The apparatus used in the NFT hydroponic system is integrated with sensors to detect the concentration of nutrition, acidity, and humidity surrounding the plants.

Seed germination was done by using rockwool as the medium. The germination process takes seven days, producing four leaves in each plantlet and transporting them into the hydroponic set with the EC value of 1.2 $mS.cm^{-1}$.

The EC value was observed every two days and adjusted to the optimal EC value of 1.2 $mS.cm^{-1}$ on the first week. From the second until the fourth week, the EC value was observed every two days and adjusted to 1.6 $mS.cm^{-1}$ with an acidity of 6.0 pH. If the pH of nutrition reaches ≥7.0. phosphoric acid was added to lower the pH to the desired value.

This study uses a randomized grouped design with 20 repetitions, and each data was analyzed through a t-test α=5% using SPSS software version 26. The independent variable being analyzed is the P1 and P2 formulas.

The independent variables that are analyzed are as such: length of plants measured from the base of the sample to the end of the leaves every week, number of leaves on each lettuce plant, new leaves that emerge every week, length of roots at harvest, the weight of plant after harvest, and the concentration of chlorophyll A and B from the highest leaves of the plant. The growth process of plants is done in a homogenous condition.

Chlorophyll A and B are obtained from a series of the extraction process. This process begins by selectively choosing the smallest leaf on the inner part of the curly lettuce from plants produced using formulas P1 and P2. A total mass of 0.3 grams of curly lettuce leaves is transferred inside a mortal and pestle. Liquid nitrogen is poured onto a mortar and pestle to grind the lettuce samples. Lettuce samples are grind until it turns to powder. The powder is then moved onto a 15ml falcon tube, and 5ml of acetone is added and left for 24 hours in the dark to extract chlorophyll A and B.

After 24 hours, the sample diluted in acetone from code P1 and P2 is transferred 1ml each into a cuvette. A total of three cuvettes are obtained for each formulation, with a total of six cuvettes. All six cuvettes are placed into a spectrophotometer and analyzed at wavelengths of 480 nm, 645 nm, and 663 nm. The results are recorded and calculated to produce the average value and standard deviation.

Results and Discussion

The differences between nutrient formulations do affect curly lettuce growth, such as its height and total of leaves from the first to the fourth week. The data can be seen in Tables 1 and 2. where the length and the total of curly lettuce leaves are better when the first nutrient formulation is given compared to the second. However, the differences that occurred did not have significant differences. This shows that having a good nutrient formula composition is the most crucial in determining hydroponic plants' growth.

Table 1. Different nutrient formula treatments affect the length of curly lettuce.

Independent Variables Measured	Average plant length (cm)			
	Week-1	Week-2	Week-3	Week-4
P1	6.5±0.07	10.8±0.12	19.8±0.28	21.5±0.52
P2	6.2±0.03	8.7±0.14	14.2±0.52	17.2±0.95
p value	0.08^{ns}	0.35^{ns}	0.04^{ns}	0.07^{ns}

Notes: * p (probability) 0.05 defines there is a significant difference with t-test Ns (non significant) with t-test p>0.05

The code P1 nutrient sample produces more amount of leaves compared to the code P2 nutrient sample, as can be seen in Table 2. However, the differences are not too significant. The amount of leaves is affected by the availability of nitrogen elements in the photosynthesis process. The increasing photosynthesis rate will produce more carbohydrates and many other organic compounds in large amounts that will later be used for organogenesis. This is shown in the total amount of leaves of curly lettuce plants. Plants need macro and micronutrients in their growth, but if one of the nutrients, both macro, and micro, is less available, then it will negatively affect the growth and development of the plants [4].

Table 2. Different nutrient formula treatments affect the number of leaves of curly lettuce.

Independent Variables Measured	Average number of leaves			
	Week-1	Week-2	Week-3	Week-4
P1	5.1±0.02	14.1±0.05	17.8±0.08	20.7±0.15
P2	4.5±0.05	12.5±0.09	15.6±0.16	17.8±0.29
p value	0.068^{ns}	0.081^{ns}	0.122^{ns}	0.085^{ns}

Notes: * p (probability) 0.05 defines there is a significant difference with t-test Ns (non significant) with t-test p>0.05

The length of roots is an indicator of the growth and the expansion of the root in increasing the area of nutrient absorption. The data analysis results at the end of the fourth week (Table 3) show that the code P1 nutrient formulation is better than the code P2 nutrient formulation, even if the differences are not too distinguishable. This means that the differences in nutrient composition and type of P1 and P2 samples do not significantly impact. The same result happens in the header variable and root's fresh weight. The differences that occur are not too significant. However, code P1 nutrient formulation is more likely to have better results than the P2 formula.

Furthermore, the chlorophyll a and b in code P1 nutrient formulation show better results when compared to the content of chlorophyll a and b in code P2 nutrient formulation. These data strengthen that the nutritional treatment of code P1 has a better effect than code P2. However, no significant effect is seen in every single variable from the first to the fourth week of observation after planting in hydroponic media. It is possible to obtain a significant difference in the nutrition formulation of code P1 rather than code P2 over a more extended period because the best time to harvest curly lettuce is at the beginning of the sixth week.

Table 3. Effects of formulated nutrients towards different variables of curly lettuce at week 3

Independent Variables Measured	Root Length (cm)	Weight of plant without root (g)	Root weight after harvest(g)	Composition of chlorophyll a	Composition of chlorophyll b
P1	25.2±0.13	18.94±4.277	4.83±1.068	21.69±1.027	22.72±0.351
P2	19.6±0.08	15.82±0.585	4.41±1.911	16.64±0.951	16.72±0.610
p value	0.390^{ns}	0.280^{ns}	0.756^{ns}	0.018^{*}	0.000^{*}

Notes: * p (probability) 0.05 defines there is a significant difference with t-test Ns (non significant) with t-test p>0.05

The control in EC value is aimed to understand the concentration level of nutrients inside the hydroponic system. In this study, the EC value is adjusted with the aim to compare the quality against both formulations. Results that were obtained indicated that within four weeks, growth of curly lettuce in P1 formula is significantly better compared to P2 in terms of growth variable such as size of leaves and length of plants. The levels of chlorophyll a and b also shows there is a significant margin with more chlorophyll detected on formula P1 compared to P2.

Summary

The comparison between P1 formula and P2 formula yielded in a better growth performance and results for P1 against the P2 formula.

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