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1st Lekantara Annual Conference on Natural Science and Environment (LeNS 2021) IOP Conf. Series: Earth and Environmental Science 1097 (2022) 012054 IOP Publishing doi:10.1088/1755-1315/1097/1/012054 1 Effect of UV LED Intensity on The Growth of Red Lettuce in Indoor Hydroponics Trinovita Z. Jingga, M.

Riza Nurtam, Hendra, Indra Laksmana, Amrizal, Jamaluddin, Hudia Polytechnic of Payakumbuh, Indonesia *tri.zuhara@politanipyk.ac.id Abstract. Microclimate control is increasingly widespread in limited agricultural environments. This is especially important for the cultivation of plants that tolerate significantly different thermal and hygrometric conditions.

Nevertheless, there is much to be done in automation and control technology in this area to achieve the best results in both quantitative and qualitative terms of the product. This applies especially to horticultural crops that are sensitive to the cultivation environment and microclimate. This work aims to characterize the microclimate parameters in a confined agricultural environment with perforated ducts for air conditioning supply.

For this work, a microclimate control unit was used instead of a lettuce crop. It was placed into a confined agricultural environment at different locations in the space to obtain the main microclimate parameters. After setting the input of the microclimate environment, the instrument measured a series of physical quantities (temperature, radiant temperature, humidity, and air velocity).

Tests were carried out by taking the optimum day temperature constant for gr owing lettuce and by varying the supply airflow rate by setting the fan speed at 30%, 50%, and

80%. The results of these tests are essential for performing real-time control of the micr oclimate environment and for managing parameters for optimization of the entire system. In addition, the air velocity test showed adequate velocity reduction and good air mixing.

The values obtained are generally acceptable for indoor cultivation and the conditions created are suitable for growing plants in such an en vironment. Light is an essential need for plants so that plants can carry out the photosynthesis process properly. In indoor DWC hydroponics system, the source of UV light is LED lights for plants.

Some of the advantages of using LED light include a small light spectrum, less heat production, low power consumption, and wavelengths of 660 m and 450 m that are needed by plants. This research project aims to create a DWC hydroponic system for growing red lettuce in an indoor hydroponics and see the effect of LED grow light on the growth of red lettuce. DWC hydroponics uses AB-Mix nutrients that are channeled through inch PVC pipes using pump power. The hydroponic rack used has a height of 1.7

m and a width of 40 cm and has 3 shelves, where each shelf has 9 nutrient containers. The red lettuce plants in the DWC system were provided with different light treatments by installing shading nets with different percentages of light penetration, namely, 75%, 50%, and 0%.

From the results of these treatments, the average yield of red lettuce was 300 grams on the top shelf, 400 grams on the middle shelf, and 600 grams on the bottom shelf. K eywo rd s : red lettuce; light-emitting diode; artificial light; photosynthesis; 1st Lekantara Annual Conference on Natural Science and Environment (LeNS 2021) IOP Conf. Series: Earth and Environmental Science 1097 (2022) 012054 IOP Publishing doi:10.1088/1755-1315/1097/1/012054 2 1.

Introduction Light-emitting diode (LED) light is used as an alternative to sunlight that plays an important role in plant growth [1]. LEDs have become a developing technology in agriculture, so the use of UV LEDs for plant lighting in Plant Factory is very important[2][3]. The development of the Plant Factory infrastructure is indeed very expensive and requires large maintenance costs[4], but this is quite promising because artificial climate control allows the plant growth process to be regulated in such a way according to the conditions for optimal plant growth[5][6].

The efficiency of plant cultivation at the Plant Factory can be increased by the use of UV LEDs. The combination of different types of LEDs can provide high fluency and

wavelengths that are tailored for crop cultivation[7]. LEDs also have low energy consumption, long service life, and stable spectral distribution.

Despite these advantages[8], the utilization of LEDs for crop cultivation has not been evenly distributed, most of them are still used for vegetable crops. LED lighting systems are mainly used commercially for leafy crops such as vegetables, fruits, and horticultural crops to optimize productivity and crop quality throughout the year[7][9][10].

In this research, red lettuce plants grown in the Plant Factory used different light intensity treatments to see the effect of light intensity on plant growth[11]. The effect of increasing light intensity was also tested because LED technology can produce high light intensity without damaging plants with the heat it generates. This study aimed to compare the effici ency of LED light source s with different light intensities in red lettuce cultivation to reveal how the quality and quantity of light affect the growth and development of red lettuce. 2. Methodology a.

Climate Control A series of temperature sensors used, namely HTC-2, functions as a reader of indoor temperature, outdoor temperature, and indoor humidity in hydroponics and also functions to display time clock during measurements. The HTC-2 device is located in a hydroponic grow room with sensor cable running outdoors, plugged for outdoor temperature readings.

The air conditioning setting was done in the morning at 07.00 with a temperature of 20°C, while the temperature was set in the afternoon at 17.00 to raise the temperature to 25°C. The temperature setting was done manually using the air conditioner remote control. Temperature for good growth is between 12°C and 26°C. Air humidity that is suitable for optimal growth of red lettuce plants ranges from 80%-90%.

Red le ttuce plants are classified as plants that are resistant to rain, so planting it in the rainy season can still give good results. Rainfall that is suitable for the cultivation of red lettuce is 1,000-1,500 mm/year. Areas that have rainfall of around 1,000-1,500 mm/year can be found in the highlands. Then, the humidity value is used as the controller programming algorithm. b.

Plant Rack Design There are several components in the DWC hydroponic design that we must understand as follows: a. The pump is a motor that drives water to drain the hydroponic media throughout the DWC system. b. The nutrient tube is the main tube to add water and nutrients to hydroponics and also a place to measure the water needs of plants in this hydroponics. c.

DO (Dissolved Oxygen) is dissolved oxygen that serves to provide oxygen to the plant roots so that the plant roots do not rot while the tool used is pumice and the driving motor is called an air compressor. d. The nutrient container is a growing media container in DWC hydroponics that flows continuously because of the nutrient pump drive. e.

The connecting pipe is a pipe to convey water to the bottom of the container and the water flows so that all containers are filled. f. The light sources used are LED grow lights , UV lamps, and ordinary lamps. On the shelf, UV-A LED is used by giving intensity treatments 1, 2, and 3. 1st Lekantara Annual Conference on Natural Science and Environment (LeNS 2021) IOP Conf.

Series: Earth and Environmental Science 1097 (2022) 012054 IOP Publishing doi:10.1088/1755-1315/1097/1/012054 3 g. The connecting pipe is a pipe to convey water to the bottom of the container and the water flows so that all containers are full. h. Hydroponic rack is a major component in hydroponics because this shelf serves as a support for the hydroponic system. Figure 1.

Plant Rack The design of hydroponics rack in Figure 1 is made with 3 shelves for the DWC hydroponics with each shelf equipped with an ultraviolet lamp with 3 light intensity treatments, namely: 75% on the top shelf, 50% on the middle shelf, and no net (100% light intensity) on the bottom shelf. Data collection was carried out every morning and evening.

The data taken were the measurement of the degree of acidity (pH) of hydroponic nutrients using a pH meter, EC data were taken using an EC meter, and plant water needs were measured by measuring the height of hydroponic nutrient water shortages from the specified limit determined. Before measuring, all the tools were checked first.

In checking the tool, there are several important things that really need to be checked, namely, the probe and the state of the pH sens or. It must be ensured that the whole system is running properly and the alarm sounds. Then, pH and EC are measured. c. Treatment In preparation for the setting of research variables, the light intensity, which apart from UV LED, is also from room lights with the following variables: 1. 0% treatment (without net), light intensity = 72.9 lm/cm 2 2. 50% treatment (with net), light intensity = 26.5 lm/cm 2 3.

75% treatment (with net), light intensity = 11.2 lm/cm 2 With the same space control values as follow : 1. Nutrition EC 560 – 840 ppm 2. Water pH 6.0 – 7.0 3. Humidity 40% – 93% 4. Temp. 20°C – 32 0 C 3. Result and Discussion Table 1 shows that the relationship

between light intensity and leaf color during observations was very significant.

This is indicated by the Pearson correlation coefficient of -0.934, which indicates a strong relationship between light intensity and leaf color. The negative correlation indicates that the higher the light intensity treatment is, the darker the leaf color will be, while the lower the light intensity treatment UV LED Nett 75% Nett 50% Red lettuce Nutrition tank Water tank 1st Lekantara Annual Conference on Natural Science and Environment (LeNS 2021) IOP Conf.

Series: Earth and Environmental Science 1097 (2022) 012054 IOP Publishing doi:10.1088/1755-1315/1097/1/012054 4 is, the lighter the leaf color will be. The same applies to the variables of plant height and number of leaves. Table 1. Correlation matrix Figure 2. Leaf color chart The leaf color chart (figure 2) shows that the olive color tone dominates in the early growth of red lettuce.

It indicated that with the three light intensity treatments, red lettuce grew equally well in the 1st Lekantara Annual Conference on Natural Science and Environment (LeNS 2021) IOP Conf. Series: Earth and Environmental Science 1097 (2022) 012054 IOP Publishing doi:10.1088/1755-1315/1097/1/012054 5 first week, but color changes occurred in the middle of the second week until harvest time.

The red lettuce that was treated with the lowest light intensity was dominated by desaturated lime green color, some had a lighter leaf color, and some even died in the third week. 4. Conclusion In our experiments, light intensity mainly determines photosynthetic activity and crop yield and is a major factor during the tillering phase.

Light quality affects stem elongation, which is affected by blue, green and red light. Leaf growth time is strongly influenced by the intensity of bright light and the decrease in light intensity causes plant growth to be not optimal, indicated by plant height and color produced.

The quality and quantity of light also changes leaf metabolism, indicated by the shape of the leaves that changes to be more elongated (where the leaves should grow to be round and wide). References [1] R. R. Shamshiri et al., “Advances in greenhouse automation and controlled environment agriculture: A transition to plant factories and urban agriculture,” Int. J. Agric. Biol. Eng., vol.

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