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Dissemination of LED grow light radiation technology to accelerate hydroponic plant growth in Sidomulyo hydroponics in Perhentian Marpoyan Village, Marpoyan Damai District, Pekanbaru City

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ABSTRACT

This research-based community service program aimed to create a series of LED grow lights for the "Sidomulyo Hydroponics" business, which increased hydroponic plant growth and improved the quality and quantity of hydroponic plants. The activity included creating a series of UV LED grow lights with radiation technology that stimulated the hydroponic plants' growth to help increase the harvest period, quality, and quantity of the plants (mustard). The methods used in implementing this research-based service were tool and material preparation, circuit design and ultraviolet LED grow light radiation setting, material and training presentation, and examination of the effect of UV grow light radiation on hydroponic plants. Experiments revealed that growing mustard plants under LED grow lights is one week faster, including harvest time.

KEYWORDS
LEDs;
Hydroponics;
Grow Lights;
UV rays;
Harvest Time

1. Introduction

Agriculture is one sector that contributes significantly to Indonesia's food supply; the majority of the Indonesian population is dependent on it. The process of good plant growth, fertile farmer's lands, and the smooth operation of this entire process is supported by abundant resources, especially sunlight, the most important natural resource for plant photosynthesis [1]–[4]. However, when unfavorable environmental conditions, such as high rainfall, occur, the photosynthesis process in plants does not work efficiently due to a lack of sunlight [1], [3], and [5]. It is something that every farmer in Indonesia, particularly hydroponic farmers [6] in Sidomulyo, has to deal with. During heavy rain, hydroponics lacks sunlight, resulting in suboptimal growth of hydroponic plants (mustard) [7], which undoubtedly harms the sustainability of this business group. To address this problem, we need a technology that can act as a substitute or even a booster to stimulate plant growth in the absence of sunlight. LED grow light technology is one of them [8].

LED grow lights are a non-natural (artificial) light source that helps and increases plant growth when radiation and supplements from natural sunlight are lacking [2], [9]. The s grow light comprises several rays that can help with photosynthesis [3, 10, 11]. Blue light promotes plant growth during the vegetative process, while red light promotes plant growth during the generative process. LED grow lights have advantages and superior results when compared to other grow lights, such as neon [12]–[14]. According to the findings of [15]–[19], the LED grow lights have a much higher efficiency than its predecessor, neon, with a maximum PAR efficiency of 80%–100%. Turning on LED grow lights requires only one-third of the power required to turn on fluorescent lamps [24]. This service community program's goal is to disseminate information about agricultural technology, specifically LED grow lights [25–27]. The workshop focused on training participants on how to install LED grow lights and giving knowledge on the effects of ultraviolet radiation from LED grow lights on plants. The Community Service (ABDIMAS) activity is an internal community service project initiated by the Islamic University

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of Riau as one of the main tasks of lecturers to contribute to the implementation of community research held at the Sidomulyo Hydroponics Group.

2. Method

The community service activities were carried out at the "Sidomulyo Hydroponics" group, located at the Sidomulyo housing complex, Camar Raya, street Marpoyan village, Marpoyan Damai district, Pekanbaru city, from November 12 to December 10, 2021. Several stages of implementation included preparing tools and materials, socialization, an intensive workshop, and a technology evaluation. It focused on improving the quality and quantity of hydroponic plant cultivation using LED grow lights [28–34]. The activity began with the preparation of all necessary tools and materials. The material was presented in the form of socialization. The materials presented included the introduction of lighting technology in agriculture, specifically LED grow lights, followed by circuit setup and ultraviolet light radiation regulation (LED grow light). The next activity was an intensive workshop entitled "Installation of LED grow light circuits in closed agricultural ecosystems and hydroponic greenhouses as environmentally friendly agricultural technology." During this session, the participants practiced installing a series of lights on a hydroponic system. The effectiveness of ultraviolet LED grow lights in terms of their radiation effect was then tested. Assistants and students assisted the presenters.

All community service socialization and workshops demonstrated a high level of enthusiasm. During the workshop session, several participant representatives practiced installing grow lights LEDs. The benchmark for the success of the socialization program, workshops, and testing was measured by the fact that participants provided feedback on each running session and were eventually able to install the LED grow lights connected to the State Electricity Company (PLN). Figure 1 depicts the community service activities which include socialization, workshops, and agricultural technology implementation

Fig. 1. The community service activities

3. Results and Discussion

According to the analysis of the activities, community service activities at "Sidomulyo Hydroponics" went very well; the community was very enthusiastic about the presence of this program, as evidenced by their presence in each meeting session from beginning to end. This activity also shifted farmers' and community groups' mindsets, particularly their awareness of adopting and applying renewable agricultural technology. From a scientific standpoint, their understanding of the urgency to transition from traditional to modern maintenance and cultivation techniques had rapidly grown, and they were able to carry out tasks during the training session on installing LED grow lights. It was one of the programs yielding a great success metric because they did not know anything about renewable

agricultural technology at the start. It is expected that agricultural technology applications will become more widespread, sustainable, and consistent among hydroponic farmers and business people.

The community service was carried out in two ways: by providing education about the renewable agricultural technology application, followed by LED grow lights training sessions, and by testing technology directly on hydroponic plants (mustard). The program was created in response to deficiencies in agricultural production, such as the low quality and quantity of hydroponic crop yields.

Introduction of LED grow lights as light sources to stimulate hydroponic plant growth acceleration

The LED grow light is an LED lamp specially made for accelerating plant growth. The LED lights used in the community service activity were four pieces mounted on four hydroponic racks with a power usage specification of 12 Watt. LED grow light is the latest innovation in agricultural technology, this innovation aims to accelerate the process of plant growth so that the productivity of agricultural crops will increase two to three times. Figure 2 depicts introduction of LED grow light as a light source to stimulate hydroponic plant growth.

Fig. 2. Introduction of LED Grow lights as a light source to stimulate hydroponic plant growth

Implementation of LED Grow Light Radiation in Hydroponic Greenhouses

The LED grow light is a LED lights type specifically designed to accelerate plant growth. The LED lights used in this activity were four pieces mounted on four hydroponic racks with a power consumption of 12 watts. This innovation aimed to accelerate plant growth, increasing the productivity in harvesting crops by 2–3 times. LED grow lights are much more effective for plant growth than non-LED grow lights, with a PAR efficiency of 80%–100% and a spectrum of light produced that is much more suitable for plant needs [7]. The LED lights used in this service were red and blue in color. The combination of red and blue colors results in a final spectrum of purple light, which increases vegetative and generative processes in plants. This color is the primary energy source in the CO2 assimilation process in plants, particularly during photosynthesis [9]. Plant chlorophyll absorbs red and blue (purple) light with wavelengths ranging from 400 to 700 nm [10]. The radiation process for hydroponic plants using LED grow light lamps is displayed in figure 3.

Fig. 3. Radiation process using solar cell-based led grow lights

LED grow lights are artificial lights that plants can use to help in photosynthesis. When there is insufficient sunlight, this lamp allows photosynthesis to continue. Figure 1-4 depicts the growth of mustard plant seeds with and without an LED grow light (non-LED grow light).

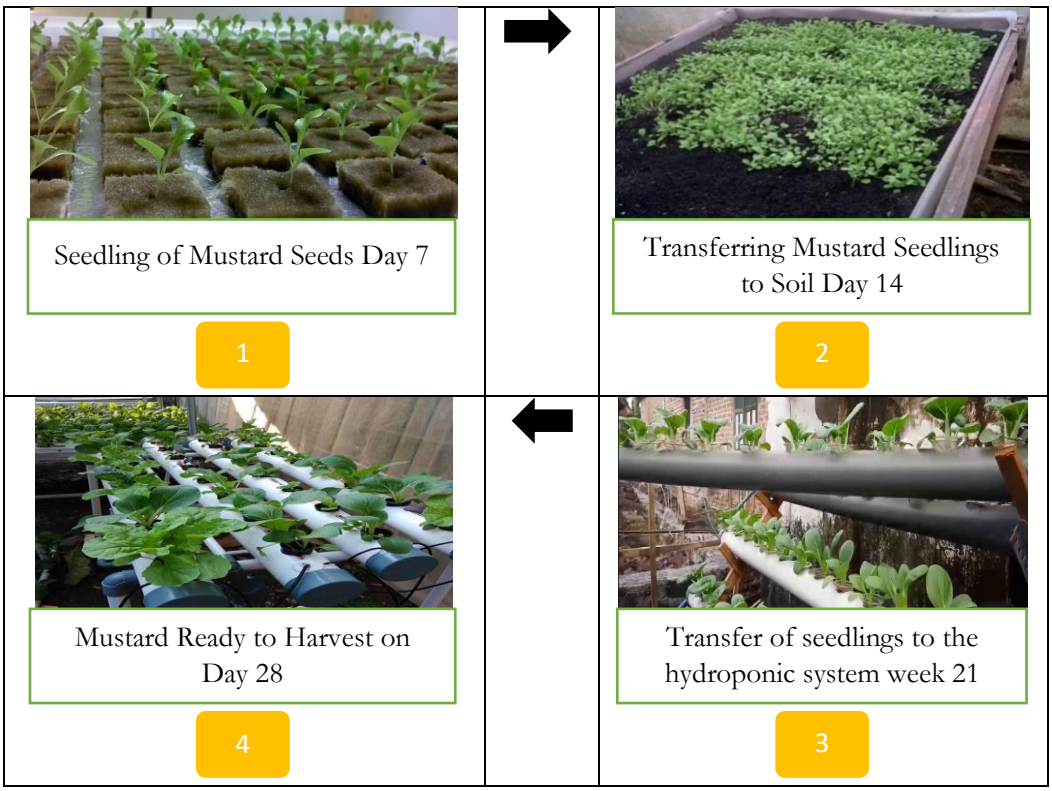

Fig. 4. Mustard plant growth without using LED grow lights

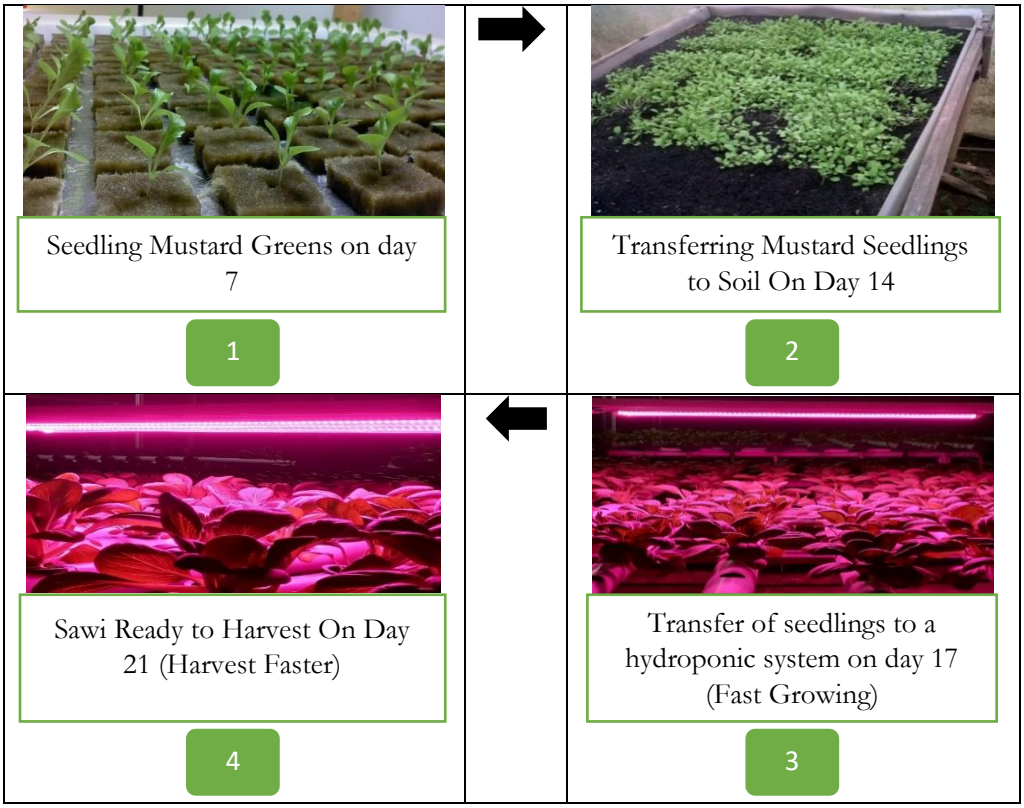

Fig. 5. Growth of Mustard Plants Using LED Grow Lights

Figures 4 and 5 depict the growth process of mustard plants from the nursery to the harvest stage. Figure 4 shows that the process takes four weeks, i.e., 28 days, and the cultivation process is carried out without using LED grow lights. Figure 5 shows that the mustard plant grows from the seedling stage to the harvest stage in three weeks or 21 days using LED grow lights.

The two mustard cultivation experiments proved that there was a very significant effect on the growth of each plant, with the longest growth shown in Figure 4, the plant's growth without using LED grow lights, and the fastest growth shown in Figure 5, the plant's growth using LED grow lights. Using LED grow lights, mustard plant growth is one week faster, including harvest time.

4. Conclusion

The activity was carried out following the COVID-19 protocol, which included washing hands, wearing masks, plastic gloves, and face shields, and keeping a safe distance between business group members to prevent virus transmission. The Sidomulyo Hydroponic Business Group has been introduced to LED grow lights and their benefits. These lights serve as the primary light for hydroponic plants at night, allowing the plants to continue their natural photosynthesis process. Hydroponic plants, on average, grow 2-3 times faster than non-hydroponic plants. When LED lights are used instead of natural sunlight, the hydroponic plants' growth is increased by 2–3 times. There was a significant effect on each plant's growth: the longest growth from seedling to harvesting without LED grow lights is 28 days, while the fastest growth is 21 days with LED grow lights. Mustard plants grown under LED grow lights take one week less time from seedling to harvest than those without LED grow lights.

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Author Contribution

Community Service (ABDIMAS) based on the results of research which is an internal program initiated by the Islamic University of Riau, as one of the main tasks of contributing lecturers in implementing research for community service held at the Sidomulyo Hydroponic Business Group.

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Conflict of Interest

The authors declare no conflict of interest.

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