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Effects of Sunlight Spectrum on Plant Physiology

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Abstract : Light is an important factor in plant growth, including white taro, because light intensity affects the rate of photosynthesis. This study aims to evaluate the effect of red and blue light spectrum from LED growlights on the growth of Pakchoy (Brassica rapa subsp. chinensis) plants. The method used was the collection of scientific articles through Google Scholar that included full text. Data were analyzed through reduction, presentation, and drawing conclusions. The results showed that blue light was more effective in increasing plant height and number of leaves through optimizing photosynthesis and stomatal regulation, while red light supported hypocotyl elongation and pigment content. Higher light intensity was also shown to increase chlorophyll content, accelerating the rate of photosynthesis. This study advances agronomy by providing specific guidelines for the use of optimal light spectrum and intensity to increase plant productivity through LED lighting technology, providing practical insights for agricultural practitioners to maximize plant growth.

Keywords: Light spectrum; photosynthesis; blue light; red light; LED grow light; plant physiology

Introduction

Plant development and growth are influenced by light availability, and this is also true for white taro. Light intensity affects the rate of photosynthesis in plants. When plants are still relatively young, the light intensity required is still relatively low until the plant approaches maturity, when the light requirement is greater. Light intensity is a crucial aspect of plant development. Shading treatment in plant cultivation can affect chlorophyll content because the amount of light absorbed by plants is reduced. In conditions of light deficiency, plants attempt to survive and use light to continue photosynthesis under low light intensity conditions. This condition can be achieved if respiration is also effective. Therefore, this study was conducted to provide shade in the form of paranet with varying densities (Zainal, A., Hasbullah, F., Akhir, N., & Hervani, D. 2022).

Indonesia has a tropical climate and high rainfall, which is often a common obstacle for Indonesian farmers. High rainfall results in a lack of sunlight, thus impeding photosynthesis. With the advancement of technology, the use of lighting media is a good alternative for faster plant growth, higher quality, and increased plant quantity. One method that can be used to manipulate sunlight is by using LED lamps, or growing lights. LED lamps are very suitable for increasing the production of vegetables and fruits. From morning to evening, plants receive sunlight, while at night they receive light from LED lamps. The longer the photosynthesis process, the more economically productive the plants will be. However, for healthy plants, LED lighting should not exceed 14-16 hours per day (Indisari, 2019). The light source must have the right light quality to initiate and maintain

photosynthesis. Chlorophyll can absorb wavelengths of red (600-700 nm) to blue (400-500 nm), so lamps designed for plant growth must emit these wavelengths. LED lights can emit light colors that can accelerate the photosynthesis process. Blue is for the vegetative phase and red is for the generative phase (Soeleman and Donor, 2013).

Based on the results of research that has been conducted on the effect of LED (Light Emite Diode) color on the growth of Pakcoy plants (Brassica Rapa Subsp. Chinensis) with parameters including the number of stems, the number of leaves, and the height of the plant, the results obtained that the color of the LED light given to Pakcoy plants (Brassica Rapa Subsp. Chinensis) has a real effect. LED lights can emit light colors that can accelerate the process of photosynthesis. The blue color for the vegetative phase is the phase for the growth of volume, number, shape and size of vegetative organs such as leaves, stems, and roots starting from the formation of leaves in the germination process until the beginning of the formation of generative organs. While red color for the generative phase, namely the growth of flower organs until the fruit ripens.

Methods

The literature review was compiled using a method of collecting articles obtained from a search of scientific articles using Google Scholar. This review only included articles containing full text. Data analysis techniques included data reduction, data presentation, and drawing conclusions.

Results And Discussion

Light is one of the factors of plant growth as an energy source. Physiological development and growth in plants are influenced by the environmental light spectrum which can trigger the photosynthesis process in plants. According to Harvenda et al. (2019) Photosynthesis is the process of plants using light to produce glucose from carbon dioxide and water which is then converted through the respiration process into pyruvate which releases adenosine triphosphate (ATP). Plants have photoreceptors which are sensors that plants have to capture certain light. Photoreceptors owned by plants include phytochromes which play a role in absorbing red and dark red light, cryptochromes absorb blue light, phototropins can detect UV-A rays. According to Bayat et al. (2018) that light will be absorbed by plant pigments in the form of chlorophyll a and chlorophyll b which are the main pigments for the photosynthesis process in plants by absorbing the red and blue wavelength light spectrum.

LED growlights have a red and blue light spectrum with specific wavelengths that can activate different photoreceptors that produce responses in biochemical and physiological processes in plants. According to Izzo et al. (2020) plant growth under red and blue light can trigger the photosynthesis process so that it can determine plant growth with the function of red light to increase hypocotyl elongation, cotyledons, pigment content and leaf area while blue light functions as a growth regulator related to plant responses to photomorphogenesis, stomatal opening, chloroplast development and leaf expansion. Based on the statement of Jensen et al. (2018) that the activity of blue light can encourage

stomatal development and can accumulate anthocyanins as well as stomatal opening and growth.

Based on the research results of Adellia et, al (2021) stated that the control sample treatment of the average height of pakcoy experienced a delay because the pakcoy plants lacked light so that the photosynthesis process was also hampered, the average height of pakcoy in 9 days after planting the seeds reached 1.55 cm. In the treatment *B* 15 (Blue, 15 Watt) the growth of plant height was very good and the photosynthesis process was optimal but experienced inhibition of stem growth so that the plants appeared elongated following the direction of the light. Light affects the direction of growth and leaf area. Plants will appear shorter because the lighting process is well absorbed so that it inhibits the growth of plant height but plants that lack light will result in tall plants and appear long because they follow the light source . The results of Slamet's research (2023) The variable of plant height has a significantly different effect on the treatment of LED growlight lamp power with an average treatment with the highest results at 18 watt lamp power with a result of 19.83 cm. The lamp power used is related to the intensity of light emitted to illuminate the plants. According to Chiocchio et al. (2022) that LED light can increase plant height and number of shoots with a mixture of red spectrum colors

LED lights exposed to lights using blue get an average result of more stems compared to plants exposed to red LED lights and without using LED lights. Growth in the control group was faster compared to the experimental group with red LED light exposure because in pakcoy microreens plants, including small plants aged 9 days and included in the vegetative phase, therefore the red LED spectrum is not really needed by plants.

Based on the research results of Adellia et al. (2021), the number of leaves during plant growth plays a significant role in capturing light. Leaf development will increasingly affect the ongoing process of plant growth and the greater the number of leaves, the more light is captured so that the process of photosynthesis increases. In Figure 3, it can be seen that using the blue spectrum in LED lights can accelerate the number of leaves compared to the control group and the experimental group with treatment given red LED lights. In the experimental group *B* 15, the average number of leaves was 3.56, having the highest number of leaves among the other experimental groups. In the control group or without the help of LED lights, growth was also maintained because the large number of young leaves grew and no leaves died, namely an average growth of 1.5. The results of Slamet's research (2023) The number of leaves of mustard greens was significantly different from a single factor of growlight power. Based on research by Yousef et al. (2021), the application of a mixture of red and blue lights can significantly increase the number of leaves, area, dry weight, and chlorophyll. The highest average was found in the 18-watt light treatment with an average value of 6.89 leaves per plant. Leaves are a crucial component of plant organs as they serve as the site of photosynthesis. Based on research by Novinanto & Andree (2019), plants that lack light intensity can result in etiolation, resulting in suboptimal plant growth, in line with research by Putri et al. (2021) that the greater the number of leaves, the more light is absorbed for photosynthesis, thus optimizing vegetative growth.

Research result Slamet (2023) The amount of chlorophyll in green mustard plants was significantly different from the single factor of LED growlight power with the 18 watt lamp

power treatment having the highest average value with a result of 272.23 μmol/m2 and the lowest average in the 6 watt lamp power treatment with an average of 102.5 μmol/m2 . The light intensity that will affect the level of chlorophyll amount is supported by research by Ikrarwati et al. (2020) the higher the light intensity received by plants, the higher the chlorophyll content in plants to capture light energy. The increase in chlorophyll content in plants can accelerate the rate of photosynthesis. Based on the results of research by Adellia et, al (2021) The growth of pakcoy microreen is influenced by various factors, one of which is the light intensity and color of light received by plants. Light intensity plays an important role in receiving energy for plants through photosynthesis by absorbing photons by pigment molecules such as chlorophyll. The color of light itself is also very important in the process of plant growth. Therefore, appropriate light control is essential for optimal plant growth. Similarly, selecting the right light during the vegetative or generative phases is crucial.

Conclusion

This research shows that red and blue light spectrums play a significant role in influencing plant growth and development, with blue light being more effective in increasing plant height and leaf number through optimizing photosynthesis and stomatal regulation, while red light supports hypocotyl elongation and pigment content. Higher light intensity has also been shown to increase chlorophyll content, which accelerates the rate of photosynthesis. This research advances the field of agronomy by providing more specific guidance on the optimal use of light spectrum and intensity to increase crop productivity through LED lighting technology, providing practical insights for agricultural practitioners to maximize plant growth.

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