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Effect of The Light Power and Lamp Color on Growth of Pak Choi Microgreens (*Brassica junicea* L.)

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Abstract. Microgreens have a higher nutrient content, thus providing significant nutritional benefits for consumers. Plant growth is influenced by various environmental factors, such as humidity, air circulation (aeration), light intensity, and the spectrum or type of light plants receive in plant cultivation. This study aims to determine the strong interaction of illumination and light colour on the growth of Pak choi microgreens (*Brassica juncea* L.) plants. This study used *a two-factor* plot strip. Factor 1 was the light power (W), which consists of W1 6 watts, W2=10 watts, W3 = 14 watts, and 18 watts. Factor 2 was the color of the lamp (P) which consists of P1 = dark blue light, P2 = light blue light, P3 = dark red, P4 = pink, P5 = combination (dark blue, dark red), P6 = combination (light blue, pink), P7 = combination (dark blue, pink), P8 = combination (light blue, dark red). A combination of treatments repeated 2 times. Observation variables included plant height, number of leaves, wet weight, total chlorophyll, and antioxidant test. This study showed that the quality and intensity of light influence the physiology of microgreens plants. This research contributes to optimizing artificial lighting-based microgreens cultivation techniques.

1 Introduction

Microgreens are small, young plants that resemble sprouts, but have a longer growth time, and are characterised by larger, deep green leaves. Microgreens have a higher nutrient content than mature vegetables, thus providing significant nutritional benefits for consumers [1] especially calcium (Ca), magnesium (Mg), potassium (K), sodium (N), and phosphorus (P). According to a study by [2], microgreens' vitamin and nutrient content can reach up to 40 times higher than that of adult plants. In addition, almost all varieties of microgreens are known to be able to produce bioactive compounds such as ascorbic acid, phylloquinone,

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tocopherol, carotenoids, as well as various vitamins, minerals, and antioxidants in greater quantities than the mature version of the plant. The plant is harvested when the first true leaves appear and belongs to the category of tender young vegetables that can be consumed directly. Microgreens are often marketed as fresh products in salads, sandwiches, or garnishes on various dishes [3].

Plant Microgreens (*Brassica rapa* L.) is also the best source of plant enzymes. Microgreens contain four to six times as many nutritious substances as some of the key nutritional components contained in plants. Microgreens include vitamins A, C, K, B6, folic acid, beta-carotene, antioxidants, and minerals such as calcium. High nutrient content in plant *Microgreens* is because plants are still undergoing catabolism. The catabolism process provides plant growth nutrients through a hydrolysis reaction from the nutrient reserves contained in plants. In the growth phase of the plant Microgreens, there is an increase in growth hormone activity, which plays a role in stimulating the accumulation of phenolic compounds [4]. But Pak choi growth is influenced by various environmental factors, such as humidity, air circulation (aeration), light intensity, and the spectrum or type of light plants receive in plant cultivation.

Light intensity is a crucial factor in plant growth. Light plays an important role in the process of photosynthesis in plants [5]. Based on that, research related to irradiation and the types of light, including dark blue, light blue, dark red, and pink LED lights, is necessary. According to [6], the colour of light absorbed by plants is red and blue light, whereas red and blue light are good for plant growth because chlorophyll absorbs red and blue light. Light is very effective in supporting photosynthesis so that plants can optimize photosynthesis.

LED lights are called plant lights because they do not cause heat that can damage the plant. LED lights are considered a safer light source because they are free of mercury content, do not produce high heat, and do not use glass materials in their manufacture [7]. Therefore, using LED lights as a light source for plant growth is the right and efficient choice to increase the production of vegetables and fruits. The plant needs to be in sunlight or LED lights with total irradiation not exceeding 14-16 hours daily [8].

Plant growth, Microgreens can take place optimally if the required intensity and quality of light are available in sufficient quantities. Light is one of the environmental factors that plays the most important role in regulating the photosynthesis process and affecting the growth and development of plants. According to Hasan et al. [9], light quality (wavelength) and appropriate intensity are major in regulating plant growth, including in the leaf formation phase and biomass production. LED lights can be an efficient solution to meet the intensity and quality of light plants need because they have relatively low energy consumption. However, more research is still required to identify the most effective combination of power (wattage) and colour spectrum of LED lights in supporting optimal plant growth. Therefore, this research was conducted to find the light color and intensity that is good for plant growth.

2 Methods

2.1 Time and Place

This research was conducted 21 days from August to September 2024 at the Agrotechnology Laboratory of the University of Muhammadiyah Malang and the University of Brawijaya Malang, Indonesia.

2.2 Research Implementation

This study used the strip plot design involving two treatment factors. Factor 1 (main plot) was the power of the LED lamp (W), which consists of W1=6 watts, W2=10 watts, W3=14 watts, and 18 = watts. Factor 2 (sub plot) was the color of the lamp (P) which consists of P1 = dark blue light, P2 = light blue light, P3 = dark red, P4 = pink, P5 = combination (dark blue, dark red), P6 = combination (light blue, pink), P7 = combination (dark blue, pink), P8 = combination (light blue, dark red). Thus, 32 treatment combinations were repeated 2 times, resulting in 64 experimental units. Light intensity was maintained for 16 hours/day.

2.3 Seed Preparation and Planting Media

The seeds used were packaged seeds with a germination rate of 85%. The planting medium used for seed germination was cocosheet. The planting medium was put into a seedbox measuring 16.5 cm long, 11 cm wide, and 3.7 cm high, and then it was watered to maintain its moisture.

2.4 Planting *Pak choi microgreens* (*Brassica juncea* L.)

Total sugar content was quantified using the anthrone reagent method. Fresh leaf samples (0.1 g) were extracted with 80% ethanol, centrifuged at 10,000 rpm for 10 min, and 200 µL of the supernatant was evaporated to dryness. The residue was dissolved in distilled water and mixed with 2 mL of 0.4% anthrone reagent in concentrated sulfuric acid. After heating in boiling water for 10 min, absorbance was measured at 600 nm, and total sugar content was determined using a standard calibration curve.

2.5 Plan Maintenance

Plant maintenance includes irradiation, which was carried out for 16 hours/day. Watering was done twice daily for 14 DAP (Days After Planting). Watering was done using ordinary water, and it should not be excessive. Watering should be done until the water is neither excessive nor dry.

2.6 Harvesting

Harvesting occurred when the plant was 14 DAP. Harvesting is done by cutting the plant just above the growing medium's surface, approximately 3-9 cm from the bottom, leaving only the roots.

2.7 Observation parameters

Observation is carried out every two days, from the day after sowing until harvesting. Harvesting is done by cutting microgreens at the base of the stem. Then the plant samples were tested for chlorophyll, and the antioxidant test was performed.

2.8 Plant height (cm)

Observation of plant height (cm) was carried out by measuring using a bar/ruler how to measure pakcoy Pak choi microgreens plants using a ruler starting from the root neck to the tip of the highest leaf observation plant height is measured starting by measuring from the tallest plant and the shortest plant and observation is carried out at intervals of 2 days until the plant is 14 DAP old (day after planting).

2.9 Number of leaves

The number of leaves was observed by calculating the number of leaves in each plant sample. The calculation is done by counting each plant sample and calculating the average number of cotyledon leaves that have developed perfectly at harvest time.

2.10 Wet weight (g)

Fresh weight observation was carried out by weighing all fresh weight per sample after harvesting. This calculation was done by weighing all samples harvested in 1 seed box.

2.11 Chlorophyll content

Laboratory tests using spectrophotometers and chlorophyll meters are used to observe chlorophyll content in microgreens plants. The Winterman de Mots method involves finding the absorbance value from spectrophotometer data using 649 nm and 665 nm wavelengths. The absorbance value is then converted into mg/L units using the formula. Meanwhile, chlorophyll levels were measured using chlorophyll meters, which were carried out by measuring plant sample leaves. Therefore, is there a difference in the treatment used on Pak choi microgreens.

2.12 Antioxidant test

Antioxidant activity was tested using a modified DPPH free radical suppression method. The solution of Pak choi microgreens extract with a known concentration (ppm) was then put into the test tube, and 1 ml of 0.4 nm DPPH solution was added, then the volume was brought to 5ml with methanol p.a. The incubated at 370 °C for 30 minutes, then the absorption was measured at a wavelength of 515 nm using a microplate reader. This test aims to see whether or not there are active compounds in the extract that have antioxidant activity in reducing free radicals (DPPH).

3 Result

3.1 Plant Height

Based on the analysis of the variety of plant heights of 4 DAP (days after planting), the study revealed a real interaction between the main plot (W) of light power (wattage) and the sub plot (P), the use of light colour. The test results differ from Tukey's (HSD) level of 5%. The effect of the interaction is presented in Table 1. The impact of each treatment was presented in Table 2.

Table 1. Interaction of Average Plant Height (cm) of Pak choi Plants at the Observation Age of 4 DAP due to the Treatment of Light Colour and Power (watts).

Treatment	Average
P1W1 = dark blue light + 6 watts	2.30 ab
P2W1 = light blue color light + me 6 watts	2.30 ab
P3W1 = dark red light + 6 watts	1.75 ab
P4W1 = pink light + 6 watts power	1.90 ab
P5W1 = combination light (dark blue, dark red) + 6 watts	1.85 ab
P6W1 = combination light (light blue, pink) + 6 watts	4.55 ab
P7W1 = combination light (dark blue, pink) + 6 watts	1.35 ab
P8W1 = combination light (light blue, dark red) + 6 watts	1.65 ab
P1W2 = dark blue light + 10 watts	2.55 ab
P2W2 = light blue color + I 10 watts	2.70 ab
P3W2 = dark red light + 10 watts power	2.45 ab
P4W2 = pink light + 10 watts power	2.60 ab
P5W2 = combination light (dark blue, dark red) + 10 watts	2.00 ab
P6W2 = combination light (light blue, pink) + 10 watts	2.55 ab
P7W2 = combination light (dark blue, pink) + 10 watts	1.85 ab
P8W2 = combination light (light blue, dark red) + 10 watts	1.15 ab
P1W3 = dark blue light + 14 watts	1.80 ab
P2W3 = light blue color light + I 14 watts	1.40 ab
P3W3 = dark red light + 14 watts	0.90 ab
P4W3 = pink light + 14 watts	2.25 ab
P5W3 = combination light (dark blue, dark red) + 14 watts	0.75 b
P6W3 = combination light (light blue, pink) + 14 watts	1.75 ab
P7W3 = combination light (dark blue, pink) + 14 watts	1.40 ab
P8W3 = combination light (light blue, dark red) + 14 watts	1.95 ab
P1W4 = dark blue light + 18 watts	1.35 ab
P2W4 = light blue color + I 18 watts	2.95 a
P3W4 = deep red light + 18 watts	2.25 ab
P4W4 = pink light + 18 watts power	2.05 ab
P5W4 = combination light (dark blue, dark red) + 18 watts	1.10 ab
P6W4 = combination light (light blue, pink) + 18 watts	2.85 a
P7W4 = combination light (dark blue, pink) + 18 watts	1.30 ab
P8W4 = combination light (light blue, dark red) + 18 watts	1.05 ab
GDP 5%	**2,61%**

Notes: Numbers followed by the same letter show intangible differences according to the Turkey (HSD) test at the level of 5%

Table 1 showed that the highest crop was in the P2W4 (light blue light + 18 watts) and P6W4 (combination light (light blue, pink) + 18watt power) treatments. It was not significantly different from the other treatments except for the combination light treatment (dark blue, dark red) + 14watt.

Table 2. Average Plant Height (cm) of Pak choi at the Observation Age of 2,6,8,10,12, and 14 DAP (days after planting) due to the Treatment of Lamp Color and Power (watts) and lamp color

Treatment	2 DAP	6 DAP	8 DAP	10 DAP	12 DAP	14 DAP
W1	0.55 ab	4.14 ab	4.58 ab	5.01 ab	5.11 a	5.16 a
W2	0.58 ab	4.58 a	4.96 a	5.48 to	5.39 a	5.46 a
W3	0.52 b	3.84 b	4.02 b	4.11 c	4.47 b	4.48 b
W4	0.77a	4.07 ab	4.52 ab	4.64 bc	5.01 to	5.06 to
GDP 5%	**0,25%**	**1,59%**	**0,71%**	**0,47%**	**0,71%**	**0,45**
P1	0,70	4.54 ab	4.91 ab	5.10 ab	5.34 a	5.40 a
P2	0,84	4.63 a	5 a	5.18 a	5.38 a	5.45 a
P3	0,56	4.23 ab	4.38 ab	4.66 bc	4.91 ab	4.98 ab
P4	0,79	4.46 ab	4.85 ab	5.09 ab	5.24 ab	5.30 ab
P5	0,49	3.35 b	4.01 b	4.21 c	4.50 b	4.59 b
P6	0,70	4.35 ab	4.69 ab	5.03 ab	5.19 ab	5.21 ab
P7	0,36	3.76 ab	4.14 ab	4.39 bc	4.70 ab	4.68 ab
P8	0,37	3.79 ab	4.16 ab	4.83 ab	4.71 ab	4.75 ab
GDP 5%	**NS**	**2,28%**	**2,01%**	**1,98%**	**1,65%**	**1,54%**

Notes: DAP (day after planting); W1 = 6 watts, W2 = 10 watts, W3 = 14 watts, W4 = 18 watts; P1 = dark blue light, P2 = light blue light, P3 = dark red light, P4 = pink light, P5 = combination light (dark blue, dark red), P6 = combination light (light blue, pink), P7 = combination light (dark blue, pink), and P8 = combination light (light blue, dark red); The numbers followed by the same letter show a difference that is not real according to the Tukey (HSD) test at the level of 5%.

3.2 Fresh Weight

The fresh weights analysis showed a significant interaction between the main plot of light power use (W) and the light colour (P). The test results, which differ from the effect of Tukey (HSD) at the 5% level, were presented in Table 3.

Table 3 showed the combination of power and color light showed that the fresh weight of the Pak choi microgreens plant (Brassica juncea L. L.) was the heaviest except for the combination of P5W2 (combination light (dark blue, dark red) + 10 watt power), P7W2 (combination light (dark blue, pink) + 10 watt power), P2W3 (light blue light + I 14 watts), P6W3 (combination light (light blue, pink) + 14 watt power), P4W4 = pink light + 18 watt power, P5W4 = combination light (dark blue, dark red) + 18 watt power, and P6W4 = combination light (light blue, pink) + 18 watt power.

Table 3. Interaction of Average Wet Weight (g) of Pak choi Plants *(Brassica juncea* L.*)* Due to Lamp Color Treatment and Power (Watts)

Treatment	**Average**
P1W1 = dark blue light + 6 watts	3.26 abcd
P2W1 = light blue color light + me 6 watts	3.08 abcd
P3W1 = dark red light + 6 watts	2.78 abcd
P4W1 = pink light + 6 watts power	3.19 abcd
P5W1 = combination light (dark blue, dark red) + 6 watts	3.09 ab
P6W1 = combination light (light blue, pink) + 6 watts	2.29 abcd
P7W1 = combination light (dark blue, pink) + 6 watts	2.42 abcd
P8W1 = combination light (light blue, dark red) + 6 watts	2.19 abcd
P1W2 = dark blue light + 10 watts	2.62 abcd
P2W2 = light blue color + I 10 watts	3.34 ab
P3W2 = dark red light + 10 watts power	3.43 a
P4W2 = pink light + 10 watts power	3.29 abc
P5W2 = combination light (dark blue, dark red) + 10 watts	2.06 cd
P6W2 = combination light (light blue, pink) + 10 watts	2.29 ab
P7W2 = combination light (dark blue, pink) + 10 watts	2.03 d
P8W2 = combination light (light blue, dark red) + 10 watts	2.20 abcd
P1W3 = dark blue light + 14 watts	2.54 abcd
P2W3 = light blue color light + I 14 watts	2.06 cd
P3W3 = dark red light + 14 watts	2.35 abcd
P4W3 = pink light + 14 watts	2.64 abcd
P5W3 = combination light (dark blue, dark red) + 14 watts	2.69 abcd
P6W3 = combination light (light blue, pink) + 14 watts	2.11 bcd
P7W3 = combination light (dark blue, pink) + 14 watts	2.73 abcd
P8W3 = combination light (light blue, dark red) + 14 watts	2.77 abcd
P1W4 = dark blue light + 18 watts	3.07 abcd
P2W4 = light blue color + I 18 watts	2.07 cd
P3W4 = deep red light + 18 watts	2.58 abcd
P4W4 = pink light + 18 watts power	2.02 abcd
P5W4 = combination light (dark blue, dark red) + 18 watts	2.045 b
P6W4 = combination light (light blue, pink) + 18 watts	2.08 bcd
P7W4 = combination light (dark blue, pink) + 18 watts	2.53 abcd
P8W4 = combination light (light blue, dark red) + 18 watts	2.55 abcd
GDP 5%	**2,07%**

Notes: Numbers followed by the same letter show intangible differences according to the Turkey (HSD) test at the level of 5%

3.3 Total Chlorophyll Plant *Microgreens*

The analysis of the total chlorophyll content showed a significant interaction between light power (W) and the lamp colour (P). Separately, light power (watts) did not have a significant effect. The test results showed a significant difference based on Tukey (HSD) at the level of 5% (Appendix 10). The effect of the interaction between treatments was presented in Table 4.

Table 4. Total chlorophyll (mg/L) interaction of Pak choi greens due to light color and power (wattage) treatment.

Treatment	**Average**
P1W1 = dark blue light + 6 watts	12.95 abcd
P2W1 = light blue color light + me 6 watts	17.85 ab
P3W1 = dark red light + 6 watts	7.75 cd
P4W1 = pink light + 6 watts power	5.60 d
P5W1 = combination light (dark blue, dark red) + 6 watts	19.25 a
P6W1 = combination light (light blue, pink) + 6 watts	16.15 abc
P7W1 = combination light (dark blue, pink) + 6 watts	8.95 bcd
P8W1 = combination light (light blue, dark red) + 6 watts	12.10 abcd
P1W2 = dark blue light + 10 watts	3.30 d
P2W2 = light blue color + I 10 watts	7.85 bcd
P3W2 = dark red light + 10 watts power	9.75 abcd
P4W2 = pink light + 10 watts power	19.30 to
P5W2 = combination light (dark blue, dark red) + 10 watts	7.25 cd
P6W2 = combination light (light blue, pink) + 10 watts	16.35 abc
P7W2 = combination light (dark blue, pink) + 10 watts	9.15 bcd
P8W2 = combination light (light blue, dark red) + 10 watts	12.65 abcd
P1W3 = dark blue light + 14 watts	17.85 ab
P2W3 = light blue color light + I 14 watts	7.80 cd
P3W3 = dark red light + 14 watts	5.60 d
P4W3 = pink light + 14 watts	19.30 to
P5W3 = combination light (dark blue, dark red) + 14 watts	8.45 bcd
P6W3 = combination light (light blue, pink) + 14 watts	16.10 abc
P7W3 = combination light (dark blue, pink) + 14 watts	9.00 bcd
P8W3 = combination light (light blue, dark red) + 14 watts	12.10 abcd
P1W4 = dark blue light + 18 watts	3.35 d
P2W4 = light blue color + I 18 watts	7.85 bcd
P3W4 = deep red light + 18 watts	9.75 abcd
P4W4 = pink light + 18 watts power	19.30 to
P5W4 = combination light (dark blue, dark red) + 18 watts	7.25 cd
P6W4 = combination light (light blue, pink) + 18 watts	16.35 abc
P7W4 = combination light (dark blue, pink) + 18 watts	9.15 bcd
GDP 5%	**16,06%**

Notes: Numbers followed by the same letter show intangible differences according to the Tukey (HSD) test at the level of 5%

Table 4 showed that the highest total chlorophyll (mg/L) levels in Pak choi microgreens (*Brassica juncea* L.) were obtained at P5W4 = combination light power (dark blue, dark red) + 18 watt power, P5W3 (combination light (dark blue, dark red) + 14 watt power), and P5W2 = combination light (dark blue, dark red) + 10 watt power.

3.4 Antioxidant Test

Based on the analysis of the variety in the antioxidant test, the use of light power (watts) and the lamp's color significantly affected *the microgreens* of Pak choi plants *(Brassica juncea* L.*)*. The test results were different from the Tukey level of 5% presented in Table 5.

Table 5. Average Antioxidant Test Results (%) Pak choi as a result of the treatment of lamp color and power (wattage).

Treatment	Average
W1: 6-watt power	16.41 b
W2: 10-watt power	20.03 ab
W3: 14-watt power	16.86 ab
W4: 18-watt power	20.30 a
GDP 5%	**6,34%**
P1: light dark blue colour	14.43 b
P2: light blue light	21.91 ab
P3: dark red light	16.23 ab
P4: pink light	14.78 b
P5: combination light (dark blue, dark red)	19.58 ab
P6: combination light (light blue, pink)	14.50 b
P7: combination light (dark blue, pink)	21.68 ab
P8: combination light (light blue, dark red)	24.10 a
GDP 5%	**16,19%**

Notes: Numbers followed by the same letter show intangible differences according to the Tukey (HSD) test at the level of 5%

Table 5 showed that the light power in Pak choi plants had high antioxidants except for the W1 (6-watt) treatment. The P8 treatment (combination of light blue and dark red) produced the highest value compared to other colour treatments. However, there was no significant difference in the treatment of P2 (light blue light), P3 (dark red light), P5 (dark blue, dark red combination light), and P7 (dark blue and pink combination light). Meanwhile, in the seedlings, the lowest scores were P1 (dark blue light), P4 (pink light), and P6 (light blue and pink combination light).

4 Discussion

Plant growth consists of several phases, one of which is the germination phase (*Germination*), and early vegetative growth phases that include Microgreens, where the need for light has essential differences depending on the plant's growth. Sprouts (*Seedlings*) do not need light to germinate because germination is the initial result of the seed germination process, which generally occurs without the need for external light, where in this process, the sprouts rely on the food contained in the cotyledons to produce energy through respiration. In some types of plants, the presence of light can actually inhibit the germination process. According to [11], "Seed germination is a physiological process that takes place predominantly through enzyme activity and is not dependent on photosynthesis, so it does not require light. Some seeds are photoblastic negative; they only germinate in the dark. In the germination phase, the hormonal activity and metabolism of Pak choi greens are regulated. Light exposure from the early stages can affect the concentration of phytohormones such as auxin, gibberellin and cytokinins that regulate plant growth and morphogenesis.

Light functions not only as an energy source in photosynthesis but also as an environmental signal (photomorphogenesis) that regulates gene expression and hormone production. During the early phase of growth, plants exposed to light experience a decrease in auxin levels in the hypocotyls, which leads to shorter but sturdy growth. On the other hand, in the dark, auxin levels increase, resulting in elongated growth (etiolation) [9].

The quality of light, particularly the red and blue wavelengths, exerts a different Influence on the concentration of plant hormones. Blue light, received by photoreceptors cryptochrome and phototropin, plays a role in inhibiting hypocotyl elongation and stimulates the production of cytokinins, which are essential in cell division and differentiation [12]. The red light absorbed by phytochromes also regulates the balance of auxins and gibberellins, influencing the elongation and germination processes. According to Zhou et al. [13], in microgreens, the regulation of hormones triggered by light from the beginning will significantly determine the final quality of the plant, both in terms of height, nutrient content, and stress resistance. Therefore, properly lighting from the germination phase is essential in producing microgreens.

Plant Microgreens. In contrast to sprouts, plant Microgreens have entered the phase of active photosynthesis, where light becomes a crucial factor. Once the cotyledon leaves open and develop, the plant begins to carry out photosynthesis to produce its own energy. Therefore, irradiation, especially with the right intensity and spectrum, such as red and blue LEDs, is essential for supporting the growth, chlorophyll development, and biomass accumulation. According to Johnson *et al*. [5], light intensity is directly proportional to the rate of photosynthesis in microgreens plants, affecting plant height, leaf area, and phytochemical content. Microgreens will experience etiolation (elongated and weak growth) and low chlorophyll production without light.

The light power (W) of 6 and 10 watts shows the best results for the high growth of the Pak choi microgreens. This can be caused by the intensity of light produced by the 6 and 10 watts of power, which is in the optimal range to support the initial vegetative growth of plants. In the early phase of growth (early vegetative phase) of the plant, Microgreens require low to medium intensity light, which is enough to support the rate of photosynthesis without causing stress. According to Taiz *et al.* [10], the power of 6 watts and 10 watts of lamps produces different light intensities in that range.

Normal light intensity can increase the synthesis of carbohydrates and hormones, such as auxin, directly supporting plant growth. This is also corroborated by the results of the research [13], which states that the use of LED lights with a power of 10 watts significantly influences plant growth. Wet weight on plants, Microgreens, Pak choi. The best results are obtained with 10 watts of power and dark red light. Fresh weight refers to a plant's fresh biomass, consisting of water and plant tissue resulting from photosynthesis. Muneer *et al.* [14] stated that higher light intensity increases the photosynthesis process, but if wattage is too high, it can cause plants to become stressed, which can inhibit plant growth. According to YAO et al. [15], dark red lights are suitable for growth because chlorophyll absorbs much blue light, so that photosynthesis takes place optimally, and red lights are ideal for plant growth because red pigments absorb red light, so that the plant size is larger. According to Singh *et al.* [16], the fresh weight of a plant reflects the results of growth activity, which is significantly influenced by the moisture content in the plant tissue and the results of the ongoing metabolic process.

According to [17], the spectrum and intensity of LED light significantly affect the plant growth of *Microgreens*, including parameters of the number of stems produced, the number of leaves, and the height of the plant. This [18] corroborates the opinion that red light affects the photosynthetic apparatus. However, monochromatic red light that is given intensively over a long period displays damage to the photosynthetic apparatus due to the effects of light toxicity [19], while light blue light significantly affects the opening of stomata and the biosynthesis of chlorophyll.

Total plant chlorophyll microgreens Pak choi, the study's results showed that the treatment using a combination of dark blue, dark red light at various powers of 6, 10, 14 and 18 watts gave the highest chlorophyll content results. This shows that the quality and intensity of light are very influential factors in the chlorophyll. The use of 6, 10, 14 and 18 watts of power can meet the needs of green micro photons which can produce narrow and directional spectrum rays and make the effectiveness of photons that reach the leaf surface high under the research that has been carried out by Singh et al. [16] states that too high light intensity reduces chlorophyll accumulation because it can cause stress and damage to the thylacoid membrane. Based on the research that has been carried out, the results show that dark blue and dark red light have the highest values. It shows that the use of a combination of dark blue and dark red light has the best results in total chlorophyll. Total chlorophyll consists of two main components: chlorophyll a and chlorophyll b. It is proven that blue light can increase MgCH, GluTR, and FeCH. In contrast, red light can reduce tetrapyrol, where the compounds that play a role in the synthesis of chlorophyll have a high absorption ability to red and blue light, so that the light spectrum is more effective in supporting the process of chlorophyll.

The highest antioxidant yield was 18 watts. The influence of lamp power plays a significant role because it can affect the secondary metabolism of plants, including the synthesis of antioxidant compounds such as flavonoids and phenolics. Muneer et al. [14] found that light intensity can affect the production of secondary metabolites in plants. Under optimal lighting conditions, plants tend to allocate energy for primary growth. However, if the light is more intense, the plant produces more phenolic compounds and flavonoids in response to light stress, which are antioxidants. The combination of light blue and dark red light provides the highest antioxidant results. This is shown from the excerpt of the results of the study that has been conducted by [20, 21], which showed that light can increase the production of flavonoids and phenolic compounds in plants, which function as natural antioxidants. Light blue light stimulates enzymes that play a role in the biosynthesis of enilpropanoids, a key metabolic pathway in the production of flavonoids [22]. In addition, from the results of the research, [23] found that exposure to dark red light combined with light blue light can increase the production of anthocyanins and flavonoids, the main antioxidant components. This is due to the results of the research that has been carried out, namely the use of a light blue and dark red combination light to produce the highest antioxidant activity because it is optimal in stimulating the production of secondary metabolites of plants.

5 Conclusion

Based on the results of the study on the influence of lamp power (wattage) and lamp colour on the growth and quality of Pak choi microgreens, it can be concluded that. Light power and light colour interacted with the growth of Pak choi plants at plant height at the observation parameters of 4 DAP (days after planting), wet weight, and total chlorophyll. The strong effect of irradiation (watts) on plant height shows the best results using powers of 6 and 10 watts at wet weights. In total chlorophyll, all wattage usage shows the best results. In the antioxidant test, 18-watt power usage shows the highest results. The effect of various lamp colours on tall Plants shows that using light blue, dark blue, pink, and a combination of light blue and dark red provides a good growth response.

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