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Article

Effect of Temperature and Light Spectrum on Led and Incandescent Lamps on the Growth of Mung Bean Sprout Plants (*Vigna Radiata*)

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ABSTRACT

Optimal plant growth is highly dependent on environmental factors such as temperature and light. This study used a quantitative experimental approach to evaluate the effect of two types of light sources, namely incandescent lamps and LEDs, on the growth of mung bean plants. The variables observed included germination rate and plant stem length. The results showed that mung bean plants given LED lighting had significantly better growth compared to plants given incandescent lighting. Light spectrum analysis showed that red and blue light emitted by LEDs were more effective in stimulating the photosynthesis process. In addition, the lower temperature around the LED lights also contributed to more optimal growth. These findings provide a scientific basis for the development of efficient and energy-saving artificial lighting systems in plant cultivation.

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INTRODUCTION

Green bean plants (Vigna radiata) are included in the legume group. This plant is very popular with the general public and is usually processed into food. This plant, besides tasting good, also contains a lot of protein. The nutritional content of green bean plants is niacin, vitamins (B1, A and E), protein, starch, calcium, fat, magnesium, manganese, iron and sulfur. In addition, this plant is usually used to facilitate bowel movements and for other treatments. In general, there are two types of plants based on the amount of sunlight exposure obtained, namely. plants that grow well with full sunlight exposure are called heliophytes, and plants that grow well with low sunlight exposure are also called ciophytes(Wimudi & Fuadiyah, 2021b)

This plant is used for research because it has many benefits and is easy to care for.Before planting, choosing the composition of the planting medium and fertilizer can affect plant growth.(Delfiya & Ariska, 2022). In addition, the use of organic liquid fertilizer from rice and mustard greens washing water can affect plant growth because organic liquid fertilizer from rice and mustard greens washing water contains sodium, phosphorus and potassium nutrients.(Hanifa et al., 2022). UtilizationTurmeric extract can also affect growth, namely phosphorus (P) and potassium (K)(Adirman Laia, 2023).Plant growth is influenced by temperature and light. Temperature according to KBBI is defined ashot and cold temperatures

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that have quantitative measurements and are measured using a thermometer. In another sense, temperature is a quantity as a means used to make a measurement which states the heat and coldness of an object.(Mahardika et al., 2023).Light is a particle (photon) that contains electromagnetic radiation, whether visible or not. Light has an electromagnetic wavelength.around 380 – 750 nm. Electromagnetic waves themselves are waves that propagate from one particle to another without requiring a medium, an example of an electromagnetic wave is sunlight which can propagate very quickly until it reaches the earth and illuminates life on earth, this energy propagates at a speed of 3 × 108 meters per second which means that in 1 second light can travel a distance of 300,000,000 m or 300,000 km(Sirait, 2020)

LED (Light Emitting Diode) is a semiconductor that can emit monochromatic light. In another sense, LED is a lamp that emits electric current light which is usually called a diode which contains a chemical substance that when several electrons pass through it there are a number of chemicals that can emit light.(Agam et al., 2015)While incandescent lamps are lamps used for lighting. These lamps produce light by passing through a heated filament. The filament is not damaged by oxidation because the lamp has glass covering the filament to prevent contact with the surrounding air.

We can see that technology has developed from year to year. Many technologies are used to make human work easier, one of which is in the agricultural sector. Many plants are grown indoors, both for decoration and food needs. Therefore, technology becomes an alternative to meet the needs of these plants, such as lighting from lamps and planting with a hydroponic system. The difference between this study and others is the combination of the effects of temperature and light in irradiating plants using LED lamps and incandescent lamps and also in the process of making simple and inexpensive practical tools.

From the background above, several problem formulations emerge, namely: first, how does temperature affect incandescent lamps and LED lamps on plant growth and second, how does light affect incandescent lamps and LED lamps on plant growth. The purpose of this study is to determine the right lamp for plant growth.

METHOD

This research was conducted in November 2023, located in Patihan Wetan Village, Babadan District, Ponorogo Regency. This research is a quantitative research with a structured, systematic, and clearly planned type of research. This study used a Randomized Block Design (RAK) with two treatments for four days. The materials and tools used in this study were 10 mung bean seeds, soil and fertilizer, sufficient water, LED and incandescent light bulbs, cardboard, rulers, thermoguns, stationery, electrical outlets, lamp fittings, scissors. The quantitative method uses an experimental research type that aims to find the effect of a particular treatment given to a variable on another variable. The data source used is a primary data source that obtains information directly through research experiments. Some of the variables in the study are as follows: 1) the independent variable used is the lamp, 2) the control variables used are a) the distance between the lamp and the plant, b) the light spectrum, c) the light intensity, d) the type of plant, e) the planting medium, 3) the dependent variable used is plant growth. The data obtained are presented in the form of images, tables and graphs, then processed in Microsoft Excel and analyzed using qualitative descriptive analysis techniques and descriptive statistics. This analysis is an analysis based on green bean growth data for 4 days.

RESULTS AND DISCUSSION

The research that was conducted for 4 days obtained resultsthat the growth of green beans exposed to LED lights with a temperature of 36 ˚C and incandescent lights with a temperature of 40˚C experienced differences in their growth. The growth of green beans can be seen in Figure 1.2.3. and Figure 4.

Tabel 1. Pertumbuhan tanaman selama 4 hari

Figure 1. First Day

Source: Personal document

Figure 2. Second Day

Source: Personal document

Figure 3. Third Day

Source: Personal document

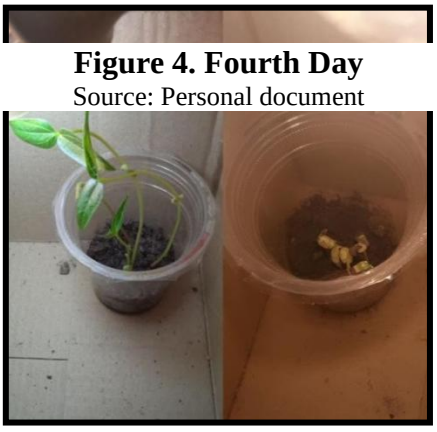


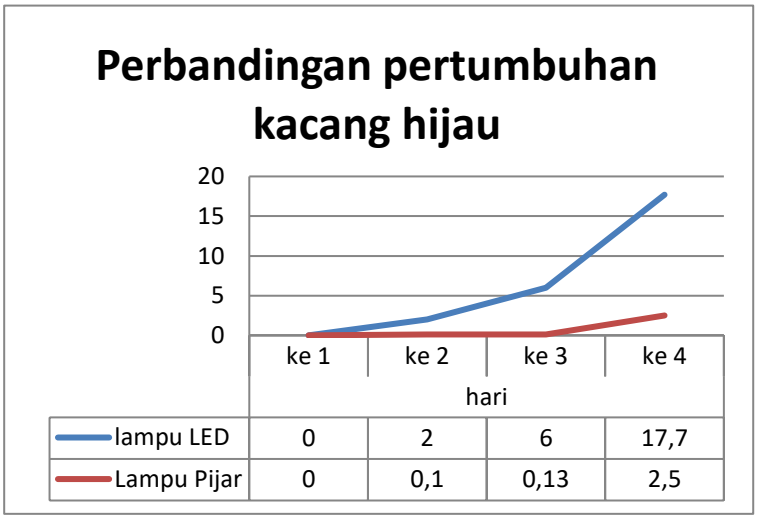
Figure 4. Fourth Day

Source: Personal document

The results of the growth of mung bean sprouts for 4 days influenced by LED light and incandescent light, which experienced differences in growth on the first to fourth days. On the first day, the mung bean plants had not experienced growth, as can be seen in Figure 1. On the second day, the mung bean plants that were exposed to LED lights and incandescent lights

experienced germination, as can be seen in Figure 2. On the third day, the mung bean plants exposed to LED lights, out of the five mung bean seeds, three seeds began to grow leaves, while the mung bean plants exposed to incandescent lights had not experienced growth at all, as in Figure 3. On the fourth day, the mung bean plants exposed to LED lights, all three plants experienced growth, namely the leaves enlarged and the stems lengthened, in addition there was one plant that had just started to grow. While in the incandescent light, the five seeds began to appear on the surface of the soil and the stems began to lengthen, as in Figure 4. The growth in the length of the mung beans from day to day can be seen in Table 1.

Table 1. Green bean growth graph



In Table 1. we can see that green beans exposed to LED lights grow longer because the growth of green beans is affected by temperature and light. The temperature and light are affected by the type of lamp used. The types of lamps we use are LED lamps and incandescent lamps. LED lamps are a type of lamp that produces little heat, while incandescent lamps can produce higher heat. This is in accordance with the temperature that we have measured, namely the temperature in the incandescent lamp environment of 40°C and the temperature in the LED lamp environment of 36°C. The distance between plants and incandescent lamps and LED lamps is made the same at around 17 cm which can affect plant growth. This is in accordance with Novinanto's research (2020) which states that a 36 W LED placed at a distance of 50 cm from lettuce plants can cause tip burn (browning at the tips of the leaves because the plant lacks calcium) on the leaves of the plant, therefore the distance of the lamp in plant cultivation also needs to be considered(Novinanto & Setiawan, 2020).

Temperature is divided into 3, namely minimum, optimal and maximum temperatures. The optimal temperature of the plant environment is around 20-38°C, at this temperature the plant can grow optimally. While the minimum temperature of plants is less than 20°C, plant growth will gradually decrease as the room temperature decreases and the plant will die when the room temperature drops above 10°C. At the maximum temperature, plant growth will be disrupted when the temperature exceeds 38°C. This is in accordance with research(Karmila & Andriani, 2019)which states that plant growth is influenced by temperature, namely minimum, optimal and maximum temperatures. If plants are at the lowest environmental temperature, the plants will not grow, while when plants are at the maximum temperature, the plant's metabolism is damaged because it cannot adapt to high temperatures so that the plants die. In addition, when plants are at optimal environmental temperatures, the plant growth rate becomes high.

Plants exposed to excessive heat can be damaged or even die because the metabolic process is disrupted due to enzyme denaturation, in addition the plants are also dehydrated and their stomata close. High temperatures are temperatures above 40˚C which causes plant cells to experience heat shock protein, namely plants experience stress due to excessive heat so that they try to protect other proteins from heat. Meanwhile, when the environmental temperature drops, plants will experience changes in cell membrane fluidity, namely its fluidity will be lost because lipids are locked into crystals that can change the transport of solutes through the membrane. This has a negative effect on the function of membrane proteins.(Maulana et al., 2023). Based on the research results, it is proven that plants exposed to LED lights experience significant growth because the temperature is optimal, while the growth of green bean plants exposed to incandescent lights is disrupted in their growth, because the temperature of the incandescent lamp is too hot which can inhibit plant growth.

Plant growth is also affected by light, for example light from LED lamps and incandescent lamps. Light quality is very important for plant growth because light is used to maintain the process of photosynthesis. If the light is too hot or too cold, photosynthesis will be disrupted. Plant growth is also affected by the spectrum of light in the lamp. The spectrum of light is a wavelength of color that can be recognized by the eye which consists of a collection of signals in the form of light. Plants can photosynthesize when the lamp has a blue wave of 400-500 nm and a red wave of 600-700 nm so that lamps that are suitable for plant growth must meet the above criteria or approach the above criteria(Santoso et al., 2020). It is known that LED light can accelerate photosynthesis because LED lights have a generative phase in the form of red and a vegetative phase in the form of blue.(Putri et al., 2021). Incandescent light can raise the temperature by 700˚C from normal room temperature. This heat makes plants should not be too close to the lamp, because the leaves can wilt and change color. The heat from the lamp also causes evaporation of groundwater. Incandescent lamps have an electrical power of 80%, so they are inefficient and wasteful of energy when used. While LED lamps have more efficient power consumption and the heat of LED lamps does not damage plants.(Santoso et al., 2020).

Factors that affect plant growth are divided into two, namely internal factors and external factors. Internal factors such as hormones and genes, while external factors such as light, temperature, pH, humidity and so on. In this study, there are factors that affect the growth of green bean plants, namely the effect of temperature and light from LED lamps and incandescent lamps. This study was conducted for 4 days with 24 hours of full illumination with LED lamps and incandescent lamps. The effect of light and temperature on LED lamps and incandescent lamps greatly affects plant growth. In addition, this study also uses soil media for planting media, because soil provides important factors in plant growth such as water, air and nutrients. In addition, the structure of the complex soil media can make plants stronger and stronger to support so that they are not easily knocked over.

CONCLUSION

This study shows that the growth of green bean plants exposed to LED lights tends to be faster compared to green bean plants exposed to incandescent lights, which has a ratio of 17.5:2.5 on the fourth day, because LED lights have an optimal temperature compared to incandescent lights which tend to be hot.

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