JPPIPA 9(8) (2023)

Jurnal Penelitian Pendidikan IPA

Journal of Research in Science Education

http://jppipa.unram.ac.id/index.php/jppipa/index

The Effect of Light Intensity and Sound Intensity on the Growth of Various Types of Chili in Indoor System

Mawarni Saputri[1*], Qory Oktaria[1], Alnia Junaidi[1], M. Agis Ardiansyah[1]

[1] Physics Education Study Program, Faculty of Teacher Training and Education, Syiah Kuala University, Aceh, Indonesia.

Received: May 12, 2023
Revised: July 7, 2023
Accepted: August 25, 2023
Published: August 31, 2023

Corresponding Author:
Mawarni Saputri
mawarni_saputri@unsyiah.ac.id

DOI: 10.29303/jppipa.v9i8.3856

Abstract: The aim of this study was to determine the effect of the intensity of the yellow LED light and the sound intensity of religious music (Asmaul Husna) on the growth of various types of chili plants in indoor system. The research method uses experimental research. This research was conducted in Baitussalam District, Aceh Province. This research was conducted for a month. Based on the results and discussion, it can be concluded that exposure to LED lights and religious music (Asmaul Husna) has a fairly good effect on the growth of stem height, number of leaves and leaf width of the three types of chili plants tested. This is because the addition of light in the form of LEDs and sound can help the plant photosynthesis process to be more productive and accelerate the growth of the third type of chili. From the three types of chili, the most significant effect is in terms of plant height, leaf width and number of leaves found in chili peppers compared to the results obtained on cayenne pepper and green chili.

Keywords: Chili plants; Intensity; Light intensity; Sound intensity

Introduction

Chili plants are vegetables that are easy to grow and are one of the foodstuffs (vegetables) that people cannot leave behind in their daily lives (Warisno & Dahana, 2018). As a tropical country, almost every corner of Indonesia has chili plants. In general, the types of chili that are widely planted are large chilies, curly chilies, bird's eye chilies and paprika. This is caused by environmental factors such as light intensity, temperature, humidity, climate, plant spacing, and soil fertility (Febrianti, 2018). Besides being able to be grown in an outdoor system, chilies can also be grown in an indoor system.

The indoor plant system is a plant growing system that uses a closed room as a place or space for growing plants. One of the advantages of an indoor system is that it can reduce pest and disease attacks on plants, besides that it can control environmental climate and soil conditions more easily, without requiring large areas of land. The lack of light intensity received by plants is a weakness of this system (Novinanto & Setiawan, 2019).

Light intensity is the amount of light energy that hits a space or object. Light intensity can also be defined as the number of light electrons emitted by a light source per unit time. When plants carry out photosynthesis, the light emitted by the light source is absorbed by the leaves and with the help of light energy (Archita , 2005; Arifin, 2007; Nadhifa et al., 2019; Aulia et al., 2020). Sunlight is very useful for plant photosynthesis, but this sunlight also has other effects such as inhibiting plant cell growth. This makes the height of plants exposed to direct sunlight shorter than the height of plants that grow in the dark. This event is called etiolation. The highest photosynthesis occurs during the day, which is between 11.00 and 14.00 and will drop sharply if covered by clouds, so artificial light is needed from electric lamps that can be turned on continuously so as not to interfere with the photosynthesis process (Haryadi et al., 2017; Robinson et al., 2021).

LED lights come in a variety of light colors ranging from red, yellow, green, blue and white. Compared to other electric lamps, LED lamps are a more environmentally friendly light source. By using LED

How to Cite:
Saputri, M., Oktaria, Q., Junaidi, A., & Ardiansyah, M. A. (2023). The Effect of Light Intensity and Sound Intensity on the Growth of Various Types of Chili in Indoor System. *Jurnal Penelitian Pendidikan IPA*, *9*(8), 6330–6336. https://doi.org/10.29303/jppipa.v9i8.3856

lights, we can save up to 85% of energy for lighting needs. LEDs are capable of producing high light intensity but with low power consumption. LED lights can also generate low heat levels so as not to affect room temperature (Kobayashi et al., 2013).

In addition to light intensity, sound intensity in the form of sound waves can also affect growth (Hassanien et al., 2014; Cai et al., 2015; Jung et al., 2018; Frongia et al., 2020). Musdarina et al. (2019) stated that the use of light and sound aids is a good alternative so that plant growth can take place more quickly, with high quality and increased quantity. Sound waves affect various growth processes, one of which is seed germination (Bochu et al., 2003; Chowdhury et al., 2014; Pujiwati & Sugiarto, 2017). Based on the above problems, a solution is needed so that chilies can grow without a lack of light and get enough light intensity in an indoor system and grow plants faster. This can be done by adding light intensity and sound intensity during the growth process. The light source used comes from LED (Light Emitting Diode) lamps and sounds from religious music (Asmaul Husna).

Research on the use of light on indoor plants has been carried out by several researchers before. In research conducted by Iwai et al. (2010), Ahmadi et al. (2019), and Ginzburg & Klein (2020) showed that the addition of red and blue LEDs can increase plant metabolism to improve fruit quality. Then research conducted by Nurdianna et al. (2018) and Novinanto & Setiawan (2019) showed that the treatment of LED and grow light lighting can affect the growth of lettuce plants. And the research that has been conducted by Zakrzewska & Kleiber (2014), Restiani et al. (2015), and Musdarina et al. (2019) shows that the effect of adding red light to plants is clearly visible in the width of mustard greens leaves which have the widest leaves among other colors of light and the number of leaves produced is greater whether or not added light color. Another study also conducted by Roziqin (2021) shows that the comparison between red LED lights and blue LED lights has a different good effect. The red LED light has a better effect on the height and yield of chili plants, while the blue LED light has a better effect on the number of leaves and the number of branches of the chili plant.

Several previous studies have used white, blue and red LED lights. However, researchers want to see the effect of the growth of chili plants when using yellow LED lights accompanied by sound intensity originating from religious music (Asmaul Husna) in an indoor system. Therefore, this study aims to determine the effect of LED light intensity and sound intensity on the growth of different chilies in an indoor system.

Method

The type of research used is experimental research which aims to obtain observational data about the effect of yellow LED light intensity and sound intensity of religious music (Asmaul Husna) on the growth of various types of chilies. The independent variables in this study were the light intensity of the LED lights, the color of the LED lights, and the sound intensity, the dependent variables in this study were plant height, leaf width, and number of plant leaves, and the control variables were sample age and treatment.

The research was conducted at the house located at Lorong T Arbie, Baet, Baitussalam District, Aceh Besar District, Aceh Province. The research was carried out from 5 February 2022 to 7 March 2022. The tools used in this study were 3 cardboard boxes, 3 yellow LED lights with a power of 12 watts, power cord, fitting, power plug, ruler, duct tape, scissors, glue, knife, camera, laptop, long socket, cellphone, speakers, hoes, an Android-based sound intensity measuring application (physics toolbox suite), and other work equipment such as stationery and calculators. The materials used in this study were cayenne pepper seeds, green chili seeds, chili pepper seeds, water, polybags measuring 30x30, soil, manure.

Parameters observed included light intensity (Cd), sound intensity (dB), and growth of the three types of chili plants (stem height, number of leaves, and leaf width). The research procedure began with making planting media by mixing soil and manure in a 2:1 ratio in a polybag, then the chili seeds were put into a polybag containing soil and manure, then planted. After that designing a construction using an indoor system from cardboard.

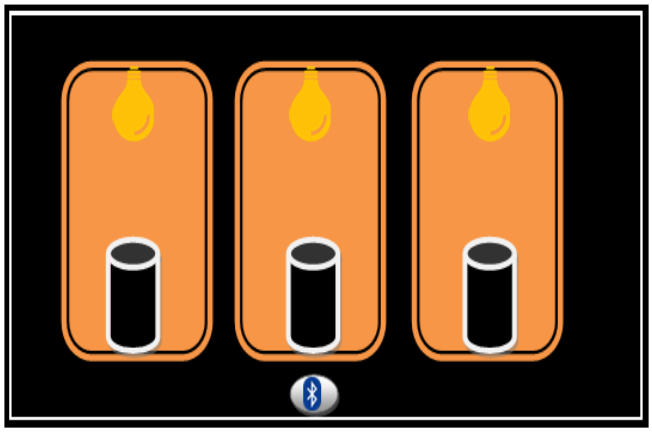

Figure 1. Schematic of planting room design

The LED lamp used has a light intensity of 109.87 cd obtained by the equation $I = \emptyset/\omega$. According to Latifah (2015) where: I = Light Intensity (cd); $\emptyset$ =

Luminous flux (lumens); ω = space angle (steradian) = 4π. The lights are installed on the top of the cardboard that has been perforated, then the three polybags containing chili seeds are placed in the cardboard that has been perforated, so that the number of lights used is 3 lamps. Chili plants were illuminated with yellow LED lights for 16 hours/day. The speaker used is connected to the cellphone using Bluetooth, placed in front of the cardboard as shown in Figure 1 with a sound intensity of 72.57 dB measured by an Android-based application.

To further clarify the design used, the actual design display is as shown in Figures 2 and 3.

Figure 2. Appearance of chili plants in an indoor system

Figure 3. External view of chili plants in an indoor system

Data collection techniques in this study are 1) Plant height. The height measurement results obtained for the research data of the three chili plants were measured using a ruler once a week. Plant height was measured from the lowest base to the very tip of the stem. This measurement is carried out until the plants are 1 month old; 2) Number of leaves. The research data was obtained from the results of calculating the number of leaves which were counted once a week. Leaves are counted from the first segment to the very end. Calculations are made on leaves that have opened perfectly. Fallen leaves are not included in the count; 3) Leaf width. The results of the calculation of leaf width obtained for research data are calculated once a week. Leaf width is measured using a ruler.

Result and Discussion

The results of measuring the growth parameters of chili plants obtained the following data:

Table 1. The Results of the Height Growth of Chili Plants Every Week

Plant Type	Plant Height			
	1st Week (cm)	2nd Week (cm)	3rd Week (cm)	4th Week (cm)
Cayenne Pepper	3	5.5	10	23.1
Green Chili	3.1	7.2	15	26.3
Chili Peppers	3	8	17.2	32

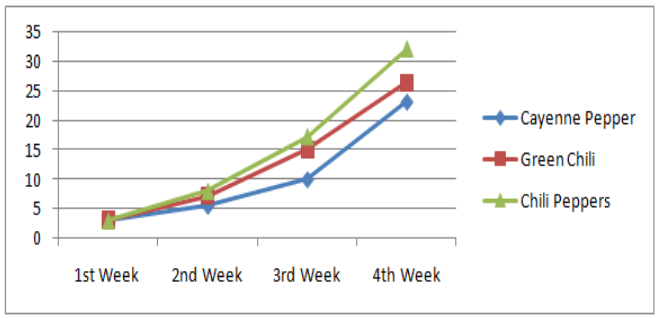

Figure 4. Graph of the results of the height growth of chili plants every week

Based on the results of table 1 and figure 4, it can be seen that the plant height of each type of chili was different after being given the same treatment using yellow LEDs and religious music (Asmaul Husna). In the first week, cayenne pepper and paprika chili have the same height, which is 3 cm and green chili has a height of 3.1 cm. In the second week, the height growth of chili peppers was faster, namely 8 cm, green chilies 7.2 cm and cayenne peppers 5.5 cm. In the third week, the height of the chili pepper plants was 17.2 cm, green chili was 15 cm and cayenne pepper was 10 cm. In the fourth week, the height of the chili pepper plants reached 32 cm, the height of the green chili plants was 26.3 cm and the height of the cayenne pepper plants was 23.1 cm.

Based on table 2 and figure 5, it shows that exposure to yellow LED lights and religious music (Asmaul Husna) also has a good effect on the number of leaves produced by chili plants. In the first week, the three types of chili plants had the same number of leaves, namely 4 strands. In the second week, the number of green chili leaves remained the same as last week,

namely 4 leaves, while the number of cayenne pepper leaves began to increase to 5 leaves and the number of chili paprika leaves also increased, namely 6 leaves. In the third week, the increase in the number of leaves was increasingly visible where the number of leaves on green chili plants was 10 leaves, cayenne pepper 16 leaves and chili peppers 28 leaves. In the fourth week, the number of chili pepper leaves reached 40 more than other types of chili plants where the number of cayenne pepper leaves was 24 and the number of green chili leaves was 18.

Table 2. The Results of Calculating the Number of Leaves of Chili Plants Every Week

Plant Type	Number Of Plant Leaves			
	1st Week	2nd Week	3rd Week	4th Week
Cayenne Pepper	4	5	16	24
Green Chili	4	4	10	18
Chili Peppers	4	6	28	40

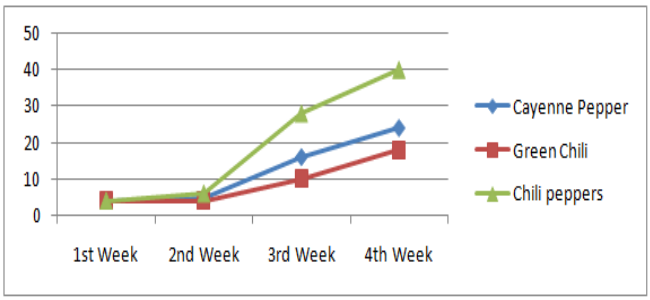

Figure 5. Graph of the results of calculating the number of leaves of chili plants every week

Based on table 3 and figure 6, it can be observed that the growth in leaf width for each type of chili plant is different. Apart from being caused by different leaf shapes, this can also occur due to the influence of the yellow LED light and religious music (Asmaul Husna) that is given. In the first week, the leaf width of cayenne pepper is 1 cm, green chili is 0.8 cm and chili peppers is 0.7 cm. In the second week, cayenne pepper and green chili have the same leaf width of 1.5 cm and chili peppers 2 cm. In the third week, the leaf width of cayenne pepper is 3.4 cm, green chili is 2.3 cm and chili peppers is 2.8 cm. In the fourth week, the leaf width of cayenne pepper is 4.5 cm, green chili is 3.5 cm and chili peppers is 4 cm.

Table 3. The Results of Calculating the Leaf Width of Chili Plants Every Week

Plant Type	Plant Leaf Width			
	1st Week (cm)	2nd Week (cm)	3rd Week (cm)	4th Week (cm)
Cayenne Pepper	1	1.5	3.4	4.5
Green Chili	0.8	1.5	2.3	3.5
Chili Peppers	0.7	2	2.8	4

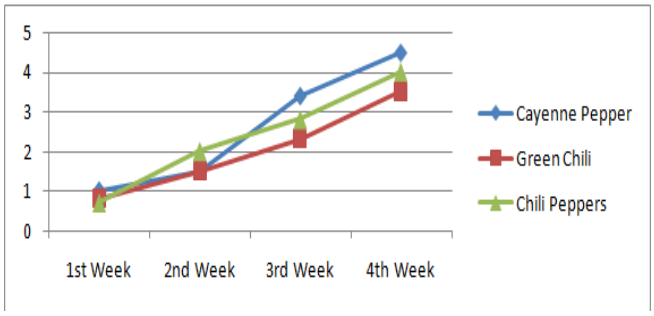

Figure 6. Graph of the results of calculating the width of the leaves of chili plants every week

Comparison of the average yield of the growth of chili plants such as bird's eye chilies, green chilies, and chili peppers every week can be seen in Figure 7 below:

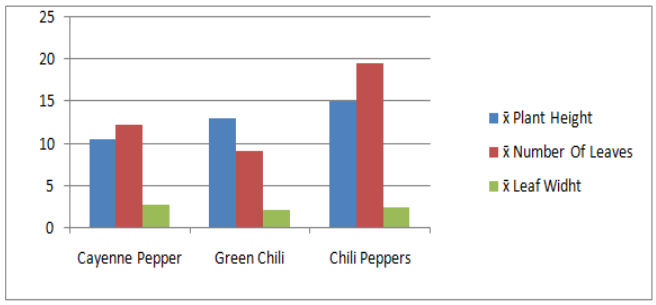

Figure 7. Graph of the results of calculating the average type of chili plant every week

Based on the graph in Figure 7, the result is that the effect of sound intensity has the most significant effect on the growth of chili peppers. The results of this study are in line with the literature which says that the right frequency of music sounds on plants will provide positive benefits. A sound has a certain frequency needed for stomata on growth to open, when a sound with a certain frequency is played on a plant, the plant's stomata will open. The opening of stomata results in more effective absorption of water so that the growth of chili peppers can develop properly (Musdarina et al., 2019).

Based on the results of the study, it was found that the use of light intensity on chili plants such as bird's eye chilies, green chilies and paprika which had been carried out for 4 weeks was well responded to by the three chili plants and obtained different growth results, this happened in addition to the fact that these chili plants have different types. differently this is also influenced by light which can have a different impact on each type of plant.

Exposure of yellow LED lights to the three types of chili plants has a fairly positive effect on plant growth and productivity. This is in accordance with the literacy that in the world of agriculture, plants can be distinguished based on the type of photosynthesis which

is divided into three parts, such as C4, C3, and CAM (Crassulacean Acid Metabolism) plants, C4 and CAM plants are plants that are more adaptive in areas where quite hot and arid for example cacti, corn and spinach, while C3 plants are more adaptive to conditions with CO2 content, for example rice, wheat, chili and soybeans, which have different physiological reactions to the influence of the intensity, quality and duration of irradiation by sunlight. Not only that, each type of plant has different properties in terms of photoperiodism, such as the length of irradiation received in one day by the plant.

The difference in the response of plants to photoperiodism makes plants classified as day neutral plants, long day plants, and short day plants. In the process of photosynthesis, plants need a visible light spectrum with a wavelength of 400-700 nm where the absorption peaks of pigment molecules in plants are located at the longest (red light) and shortest (blue light) wavelengths. As for this study, for the photosynthesis process used is a yellow LED light, where the spectrum in yellow has a wavelength of 570-590 nm.

In addition, sound exposure to plants also has a fairly good effect on stem height, stem width and number of leaves compared to plants that are not given sound exposure, the provision of religious music (Asmaul Husna) has the most effect on the number of leaves and plant height. According to Yuwono et al. (2021) the effect of exposure to the sound of Asmaul Husna is good for plants. because the vibrations generated from exposure to the sound of Asmaul Husna will transfer energy to the leaf surface and stimulate the leaf stomata to open wider. This is in accordance with research conducted by Kim et al. (2017) and Kim et al. (2021) showing that sound waves have the potential as an agricultural tool to improve plant growth performance. As well as research that has been conducted by Chaidir et al. (2019) shows that there are significant differences in responses for height, number of leaves, roots and widening of stomata) to samples given the sound of the holy verses of the Qur'an compared to samples without treatment. So based on the results of research that has been done on plants that are given additional light and exposed to sound produce better plant growth compared to plants that are only given additional lights or only given sound.

Conclusion

Based on the results of the research that has been done, it can be concluded that exposure to light intensity using yellow LED lights and sound intensity from religious music (Asmaul Husna) has a fairly good effect on the growth of stem height, leaf number and leaf width on the three types of chili plants tested compared to with plants that are not exposed to light and sound at all or are only given additional light or only sound. The most significant effect can be seen in chili pepper plants starting in terms of plant height, leaf width and number of leaves compared to cayenne pepper and green chili plants. This is because the addition of light in the form of LEDs and sound can help the photosynthetic process of plants to be more productive and accelerate the growth of the three types of chili even though the growth rates of the three types of plants vary in stem height, number of leaves and leaf width they produce.

Author Contributions

Mawarni Saputri conceptualized the research idea, designed of methodology, management and coordination responsibility; Qory Oktaria analyzed data; Alnia Junaidi conducted a research and investigation process; M. Agis Ardiansyah conducted literature review and provided critical feedback on the manuscript.

Funding

This research was funded by all author, and no conflict in the funding.

Conflicts of Interest

The authors declare no conflict of interest.

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