The Effect of Exposure Length to Jazz Music on The Production of Pakcoy (Brassica Rapa, L) in Indoor Cultivation

Devi Suharni Tamba, I Made Anom Sutrisna Wijaya*, I Gusti Ketut Arya Arthawan

Department of Agricultural Engineering and Biosystem, Faculty of Agricultural Technology, Udayana University, Badung, Bali, Indonesia
*email: anomsw@unud.ac.id

Abstract

The photosynthesis process in indoor cultivation system does not get optimal sunlight, therefore LEDs can be used as artificial light. The red-blue color is a color that has a positive effect on plant growth. In addition, to increase the rate of photosynthesis, one of the technology advances that can be used is sonic bloom. Sonic bloom is the delivery of high-frequency sound waves in plants to stimulate the opening of the leaf stomata mouths which is accelerating the rate of absorption of carbon dioxide, water and soil minerals. In this study, Pakcoy was exposed to jazz music to determine the effect on production of Pakcoy, and the best length of exposure. The length of exposure to jazz music was 1 hour, 2 hours, 3 hours, 4 hours, and 5 hours starting from 07.00 WITA. The type of jazz music used was Jazz Rock with the musical instrument Gambandella by Psychedelic Jazz-Rock Fusion with a frequency of 86 – 21189 Hz and a sound intensity of 65-95 dB. In the growth chamber, artificial light red-blue LED was used with a light intensity of 1900 – 2100 Lux. The results showed the length of exposure to jazz music significantly affected the production of Pakcoy. The exposure length of 5 hours showed the best result (fresh harvest weight 55.49 gs, root wet weight 2.18 gs, and biomass 2.95 gs). In conclusion, exposure length to jazz music has a positive effect on Pakcoy production.

Keywords: jazz music, pakcoy, production, sonic bloom

INTRODUCTION

Indoor cultivation (plant factory) or commonly called indoor cultivation is a cultivation technique that is carried out in a room or building. What's more, the increasing conversion of agricultural land has led to less land for cultivating food crops such as vegetables. According to data from the Badan Pusat Statistik (2018), around 60,000 hectares of agricultural land have been converted to non-agricultural land every year. This results in lower food production land so that cultivation indoors can be an alternative to overcome this problem. Plant growth will be optimal if the plant gets a climate that is in accordance with the conditions for plant growth.

In the indoors cultivation system for the photosynthesis process, plants do not get optimal sunlight. Therefore to manipulate sunlight, artificial light is used. Artificial light used in plant cultivation must help the optimal photosynthesis process. LED lamps (Light-emitting diode) have a wavelength of 400 nm - 700 nm and do not produce high temperatures so that they can be used to increase plant growth (Armanyah et al., 2013). A study conducted by Wahyuni et al., 2017 stated that the granting of red-blue LED lights 1 cycle provides the best growth results in chrysanthemum plants seen from plant height, several leaves, canopy area, and stem diameter. LED lights can be an alternative source of lighting for hydroponically grown lettuce (Kobayashi et al., 2013). According to Chen et al., 2020 that the spectrum of monochromatic blue LED (BB) and red, blue, or green lights (RB and RBG) encourages potato growth in vitro. Several factors affect the process of plant photosynthesis are carbon dioxide, water, light, and nutrients. Plant growth will be maximized if the photosynthesis process of plants is optimal. One of the technological developments to increase the rate of photosynthesis is the provision of high-frequency sound waves (sonic bloom) to plants that can stimulate the opening of the leaf mouths, thereby accelerating the rate of absorption of carbon dioxide, water, and minerals in the soil (Mulyadi et al., 2005). Sound vibrations can trigger the opening of the stomata. Stomata opening occurs when the two guard cells vibrate due to increased pressure due to the influence of sound resonance which causes water to enter the guard cells and is able to increase the osmotic pressure (Nur Kadarisman et al., 2011). Guard cells are one part of the stomata so that the guard cells will swell because they absorb a lot of water. According to Song et al., 2021 the application of sonic bloom has the potential to increase plant growth indicated by an increase in stomata opening, germination, plant growth, and productivity. This sonic bloom application has been widely used with various types of music and sounds for different
plants. According to Prasetyo et al., 2019, in his research on designing vegetable growth and productivity drive with monogenic block and monochromatic light, it was obtained that the provision of monogenic block and light can increase the productivity of pakcoy as much as 40.08% of plants that are not given treatment. Research on music exposure to the productivity of mustard greens found that exposure to classical music for 3 hours gave the best results in terms of morphology and productivity (Prasetyo et al., 2014). The treatment of jazz, gamelan, and heavy metal music for 3 hours could increase the growth of lettuce plants compared to controls in measuring plant height, number of leaves, biomass, plant leaf area, biomass, wet weight, and leaf green index, from the three treatments used. Given gamelan music treatment got the best results and jazz music got less good results compared to plants given exposure to gamelan music and hard rock (Prasetyo, 2017).

This research was conducted by combining the duration of exposure to jazz music and red-blue LED light on indoor pakcoy mustard cultivation. The selection of mustard pakcoy as the object of research is based on the fact that mustard pakcoy is a plant that is sensitive to environmental changes and is in great demand by the public for consumption. According to the Badan Pusat Statistika (2018), the production of pakcoy plants in Indonesia increased 1.34% in the last five years, from 602,468 tons/year in 2014 to 635,982 tons/year in 2018. The increasing production of pakcoy shows that there is an increase in demand by the Indonesian people. The use of jazz music in this study is because jazz music has regular rhythms and tones and gives the effect of flow to the listener. The Effect flow can help people free from emotional disturbances so they can focus on their work (Pramono et al., 2019). It is hoped that the application of jazz music to pakcoy can help the growth of pakcoy and increase the production of pakcoy.

RESEARCH METHODS

Place and Time Research
This research was conducted at the Green House Agricultural Engineering Management System Laboratory Faculty of Agricultural Technology, University of Udayana Bukit Jimbaran. The research period lasts for 3 months from June-August 2021.

Materials and Tools
The tools used in this study include: the growth chamber size 80cm x 80 cm x 80 cm was equipped with a 5 cm thick silencer, a speaker with a frequency response specification of 280 Hz – 18 kHz with a signal to noise of 65-95 dB, red and blue LEDs, drivers LED and exhaust. The tools used to measure the parameters are a ruler, analytical scales Kern ALS 120-4N, Baoshishan DHG-9030A oven, SPAD Chlorophyll Meter MC-100, chamber photo box equipped with camera smartphone Samsung J6+ 3/64GB and Lenovo-ideapad 330 laptop, with specifications as follows: Intel® Core™ i3, 4GB RAM, hard disk 1 TB equipped with software Matlab2013 and Adobe Photoshop CS6. Other tools used were thermohygrometer, analog soil pH meter, TDS meter, and Lightmeter MS-1300 Voltcraft. The materials needed were pakcoy (Brassica rapa L.) seeds from Benih pedia, fertile soil, compost, Multi Green liquid NPK, Curacron 500 EC syngenta liquid pesticide, polybag, and water.

Experimental Design
Research stages carried out starting from site preparation, tools and materials preparations, seeding, transplanting, and plant maintenance, observation and measurement of variables, analysis, and data processing. This study used a completely randomized design (CRD) consisting of exposure to jazz music 1 hour (P1), 2 hours (P2), 3 hours (P3), 4 hours (P4), and 5 hours (P5). The data obtained were then analyzed by analysis of variance of the observed variables, then statistical analysis continued with Duncan's test using the SPSS application Statistics 25.

Research Implementation
The stages start with the preparation of tools and materials and the manufacture of a growth chamber. Then sow the seeds for 14 days after 14 days the seedlings are transferred to polybags which has been filled with a mixture of fertile soil and manure in a ratio of 2:1. The treatment was given on the 6th day in a growth chamber which was covered with a silencer with a thickness of 5 cm and equipped with a red-blue LED and a light intensity of 1900 ± 2200 lux with irradiation time of 12 hours starting at 06.00 WITA until 18.00 WITA. Plant maintenance is carried out from the beginning of seeding, transplanting until before harvest in the form of watering plants, providing weed sanitation nutrition and spraying pesticides. Watering is done 2 times a day with a dose of water as much as 50 ml/plant for one flush. Watering of nutrients was carried out on 7 DAP (Day After Planting) 500 ppm, 14 DAP 700 ppm, 21 DAP 900 ppm, 28 DAP 1,200 ppm, 35 DAP 1,300 ppm, and 42 DAP 1,300 ppm. Weed sanitation was carried out once a week and pesticide spraying was carried out on days 14 DAP and 28 DAP.

Observed Parameters
The observed parameters consist of the total chlorophyll content, fresh weight harvest, biomass 357
and length root of pakcoy. The data obtained is then analyzed with ANOVA variance analysis, then statistical analysis continues with Duncan test using SPSS Statistical 25 application.

**RESULT AND DISCUSSIONS**

**Effect of Exposure length to Jazz Music on the Total Chlorophyll Content of Pakcoy**

The value of SPAD pakcoy in each treatment showed different values. The difference in the value of SPAD pakcoy in each treatment is presented in the form of a graph as shown in Fig 1. Based on the graph, the value of SPAD pakcoy does not show significant differences between treatments. However, the SPAD value of the 5-hour jazz music exposure length treatment showed a higher SPAD value compared to other treatments. While the SPAD value of the 1-hour jazz music exposure length time showed the smallest SPAD value compared to other treatments.

The results of the ANOVA test showed that the SPAD value of exposure length to jazz music 1 hour, 2 hours, 3 hours, 4 hours, 5 hours of pakcoy at the age of 0 to 4 weeks showed no significant effect on each treatment. At the age of 5 and 7 weeks, the exposure length to jazz music 1 hour, 2 hours, 3 hours, 4 hours, 5 hours had a significant effect on Pakcoy’s SPAD value. Therefore continued Duncan examination which can be seen in Table 1.

![Figure 1. SPAD pakcoy values graph at each treatment](image)

**Table 1.** Average values of SPAD pakcoy at each treatment

<table>
<thead>
<tr>
<th>Treatment</th>
<th>0 W</th>
<th>1 W</th>
<th>2 W</th>
<th>3 W</th>
<th>4 W</th>
<th>5 W</th>
<th>6 W</th>
<th>7 W</th>
</tr>
</thead>
<tbody>
<tr>
<td>P1</td>
<td>22.78a</td>
<td>23.63a</td>
<td>24.19a</td>
<td>24.53a</td>
<td>25.16a</td>
<td>25.73a</td>
<td>27.46a</td>
<td>29.34a</td>
</tr>
<tr>
<td>P2</td>
<td>22.75a</td>
<td>23.09a</td>
<td>24.27a</td>
<td>25.44a</td>
<td>26.39a</td>
<td>26.88ab</td>
<td>27.94a</td>
<td>29.70a</td>
</tr>
<tr>
<td>P3</td>
<td>23.29a</td>
<td>25.01a</td>
<td>25.77a</td>
<td>26.56a</td>
<td>26.72a</td>
<td>27.21ab</td>
<td>28.40ab</td>
<td>30.20a</td>
</tr>
<tr>
<td>P4</td>
<td>22.72a</td>
<td>23.93a</td>
<td>25.90a</td>
<td>27.29a</td>
<td>27.73a</td>
<td>29.37b</td>
<td>30.48bc</td>
<td>31.20a</td>
</tr>
<tr>
<td>P5</td>
<td>23.14a</td>
<td>25.01a</td>
<td>25.75a</td>
<td>26.80a</td>
<td>27.48a</td>
<td>29.61b</td>
<td>31.03c</td>
<td>33.85b</td>
</tr>
</tbody>
</table>

Note: Different letters behind the numbers in the same column indicate significantly different values based on Duncan's test with a level of $\alpha$ 5%; W = Week

Based on Duncan's test, the SPAD value of Pakcoy's treatment of 5 hours of exposure to music was significantly different from the SPAD value of the treatment of 1 hour of exposure to jazz music and not significantly different from the SPAD value of the treatment of 2 hours, 3 hours and 4 hours of jazz music exposure. At the age of 6 weeks, the SPAD value of 5 hours of exposure to jazz music was significantly different from the SPAD value of the treatment of 1 hour, 2 hours, 3 hours of jazz exposure and was not significantly different from the 4-hour long exposure to jazz music. At the age of 7 weeks, the SPAD value of the 5-hour music exposure treatment showed a significantly different value from the other treatments. At the age of 5 to 7 weeks, the average value of SPAD for 5 hours of exposure to jazz music showed the highest average value compared to other treatments, while the average value of 1 hour of jazz music exposure showed the smallest value compared to other treatments. In
accordance with the exposure to gamelan gong kebyar music for 3 hours and the red-blue LED light has a positive effect on the greenness of the leaves of the pakcoy plant (Sigrarawan et al., 2020). The results of data analysis show that the longer exposure to jazz music is given to Pakcoy, the higher the SPAD value. The higher the green color of a leaf, the higher the chlorophyll content. So that the higher the chlorophyll content, the rate of photosynthesis will increase, the production of plants will increase (Hasan & Fitriyani, 2011).

**Effect of Exposure Length on Pakcoy’s Root Length**

The length of the root produced by the 5-hour jazz music exposure treatment observed at 0 to 7 weeks of age resulted in a longer root length than other treatments. The difference in root length is presented in Fig 2 and Fig 3.

The results of the test one way Anova showed that the length of exposure to jazz music of 1 hour, 2 hours, 3 hours, 4 hours, 5 hours significantly affected the root length of the pakcoy plant, so Duncan’s further test was carried out to determine the difference in root length values in each treatment which can be seen in Table 2. In his research, the length of the roots of the mustard pakcoy plant that was given gamelan gong kebyar music and red-blue LED light produced longer roots and more fibers than plants without treatment and other treatments.

**Table 2.** The average value of root length (cm) of pakcoy at each treatment.

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Average of root length (cm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>P1</td>
<td>10.02a</td>
</tr>
<tr>
<td>P2</td>
<td>10.22a</td>
</tr>
<tr>
<td>P3</td>
<td>10.54a</td>
</tr>
<tr>
<td>P4</td>
<td>11.22a</td>
</tr>
<tr>
<td>P5</td>
<td>14.94b</td>
</tr>
</tbody>
</table>

**Figure 2.** Differences in *pakcoy* root length at each treatment

**Figure 3.** *Pakcoy* root length graph at each treatment
Note: Different letters behind the numbers in the same column indicate significantly different values based on Duncan’s test with a level of $\alpha$ 5%

This research resulted in an average root length of 23.60 cm pakcoy with a combination of gong kebyar music for 3 hours and red-blue LED lights with a light intensity of 2500-2990, this is presumably due to the lack of light intensity given to pakcoy in this study. Photosynthesis takes place optimally because it is given red-blue light so that it can be absorbed by plants more than 90% (Lakitan, 2013).

**Effect Of Exposure Length to Jazz Music on Fresh Weight Harvest Of Pakcoy**

Fresh weight harvest produced by length exposure to jazz music 5 hours after harvest resulted in higher fresh weight harvest than other treatments. The difference in the fresh weight harvest is presented in the form of a graph which can be seen in **Fig 4**.

![Figure 4. Fresh weight harvest graph of pakcoy at each treatment](image)

The results of the test one way Anova showed that the exposure length to jazz music 1 hour, 2 hours, 3 hours, 4 hours, 5 hours significantly affected the fresh weight harvest of pakcoy, so Duncan’s further test was carried out to determine the difference in the value of fresh weight harvest at each treatment which can be seen in **Table 3**.

**Table 3. The average value fresh weight harvest of pakcoy at each treatment**

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Fresh Weight Harvest (g)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Header (g)</td>
</tr>
<tr>
<td>P1</td>
<td>21.67a</td>
</tr>
<tr>
<td>P2</td>
<td>21.78a</td>
</tr>
<tr>
<td>P3</td>
<td>26.64a</td>
</tr>
<tr>
<td>P4</td>
<td>38.45b</td>
</tr>
<tr>
<td>P5</td>
<td>55.49b</td>
</tr>
</tbody>
</table>

Note: Different letters behind the numbers in the same column indicate significantly different values based on Duncan’s test with a level of $\alpha$ 5%

Based on the results of Duncan’s test, the value of fresh weight of headers, treatment exposure length to jazz music was with jazz 5 hours of significantly different from the fresh weight of headers of other treatments, with the highest average value compared to other treatments, while the fresh weight of headers of treatment with 1 hour of exposure length to jazz music showed the smallest value compared to other treatments. Meanwhile, the fresh weight header value of roots showed that the exposure length to jazz music for 5 hours was significantly different from the other treatments, with the highest average value compared to other treatments and the exposure length to jazz music for 1 hour showed the smallest value compared to other treatments.

Giving exposure to classical music for 3 hours starting at 07.00-10.00 resulted in a plant wet weight of 57.1% compared to control plants (Prasetyo *et al*, 2014). In a study using natural sound with a frequency of 40-200 Hz for 3 hours starting at 09.00 on strawberry plants, it can increase the amount of fruit production by 16.6% and total fresh weight by 50% (Lirong Q *et al*, 2010). The results of the analysis show that the exposure length to jazz music given the fresh weight harvest of pakcoy, the greater the harvest 5 hours of exposure length to jazz music increased the amount of plant chlorophyll so that the rate of photosynthesis of plants also increased. Photosynthesis that runs smoothly will increase the photosynthate produced by plants which are translocated throughout the plant tissue so that it affects the plant's fresh weight which is getting bigger. The fresh weight harvest of crop is related to the number of leaves and canopy area of the plant, the
more leaves and canopy area, the amount of chlorophyll will also increase. Chlorophyll which plays a role in the process of photosynthesis to produce photosynthesize. If the photosynthesize produced is increasing, the fresh weight of the plant will also increase (Lirong et al, 2010). Amin et al., 2017 the weight of fresh crop harvest are related to the number of leaves and the area of the plant canopy, the more leaves, and canopy area then the amount of chlorophyll will also increase. Chlorophyll plays a role in the process of photosynthesis to produce photosynthesis. If the resulting photosynthesize increases then the fresh weight of the plant will also increase.

Effect Of Exposure Length To Jazz Music On Pakcoy Biomass

Pakcoy biomass produced by exposure length to jazz music 5 hours after harvest resulted in higher biomass than other treatments. The difference in biomass is presented in the form of a diagram which can be seen in Fig 5.

![Figure 5. Pakcoy biomass of exposure length at each treatment](image)

The results of the test one way ANOVA test results revealed that the exposure length to jazz shows the real effect of the header and root biomass pakcoy so do a further test Duncan to determine. The difference in value biomass as shown in Table 4.

Table 4. The average value biomass of pakcoy at each treatment

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Header (g)</th>
<th>Root (g)</th>
</tr>
</thead>
<tbody>
<tr>
<td>P1</td>
<td>1.18a</td>
<td>0.05a</td>
</tr>
<tr>
<td>P2</td>
<td>1.26ab</td>
<td>0.06ab</td>
</tr>
<tr>
<td>P3</td>
<td>1.89bc</td>
<td>0.10ab</td>
</tr>
<tr>
<td>P4</td>
<td>1.95c</td>
<td>0.10b</td>
</tr>
<tr>
<td>P5</td>
<td>2.83d</td>
<td>0.15c</td>
</tr>
</tbody>
</table>

Note: Different letters behind the numbers in the same column indicate significantly different values based on Duncan's test with a level of $\alpha$ 5%

Based on the results of the Duncan test, the header and root biomass of pakcoy, the exposure length to jazz music 5 hours for header and root was significantly different from the biomass of other treatments, with the highest average value of biomass compared to other treatments. Meanwhile, the header and root biomass values of 1 hour of exposure length to jazz music showed the lowest values compared to other treatments. The results of the analysis show that the exposure length to jazz music given Pakcoy biomass also increases. Giving music helps the opening of leaf stomata which affects the rate of photosynthesis which can increase photosynthesis. The accumulated photosynthesize can increase the dry weight of the plant so that the higher the dry weight value, the higher the plant growth (Protobiont, 2018).

According to Gautama et al., 2018 awarding Balinese gamelan music gong kebyar can increase the productivity of mustard pakcoy with a high dry weight.

CONCLUSIONS

The treatment of exposure length to jazz music affects the production of pakcoy. The treatment of exposure length best jazz music is exposure length of 5 hours of music with the highest value (fresh harvest weight 55.49 gs, root wet weight 2.18 gs, and biomass 2.95 gs).

REFERENCES

Pertumbuhan dan Produksi Tanaman Pakcoy (Brassica Rapa, L.)


