

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*

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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 Statistika (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 (Armynah *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 mong sonic bloom and monochromatic light, it was obtained that the provision of sonic bloom 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

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**.

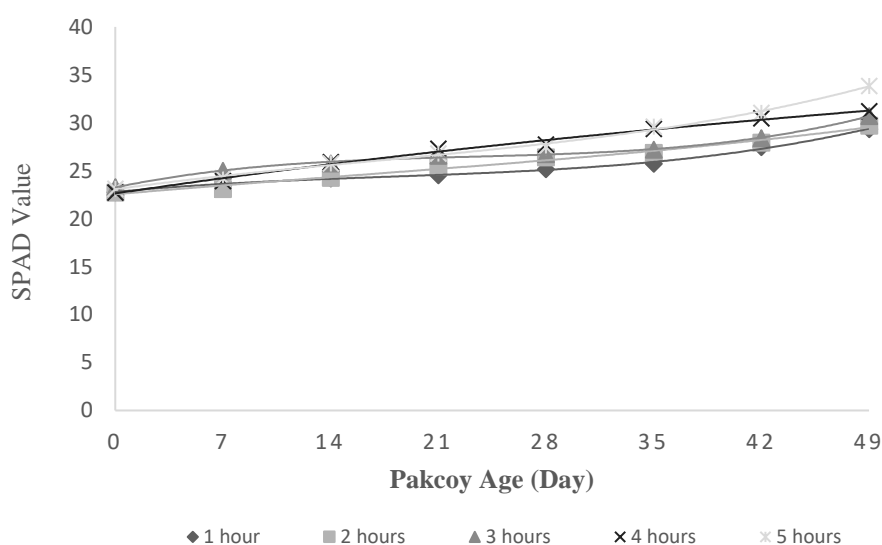


Figure 1. SPAD *pakcoy* values graph at each treatment

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

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

Note: Different letters behind the numbers in the same column indicate significantly different values based on Duncan's test with a level of α 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 (Sigmarawan *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**.

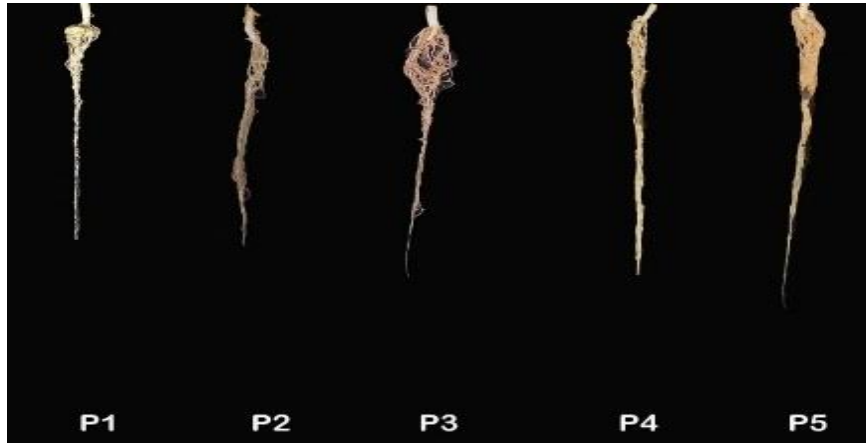


Figure 2. Differences in *pakcoy* root length at each treatment

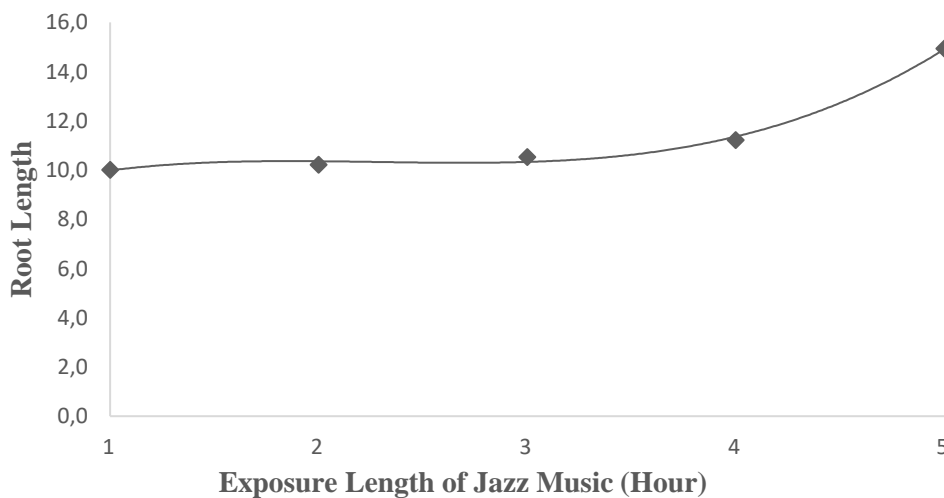


Figure 3. *Pakcoy* root length graph at each treatment

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.

Treatment	Average of root length (cm)
P1	10.02a
P2	10.22a
P3	10.54a
P4	11.22a
P5	14.94b

Note: Different letters behind the numbers in the same column indicate significantly different values based on Duncan's test with a level of α 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**.

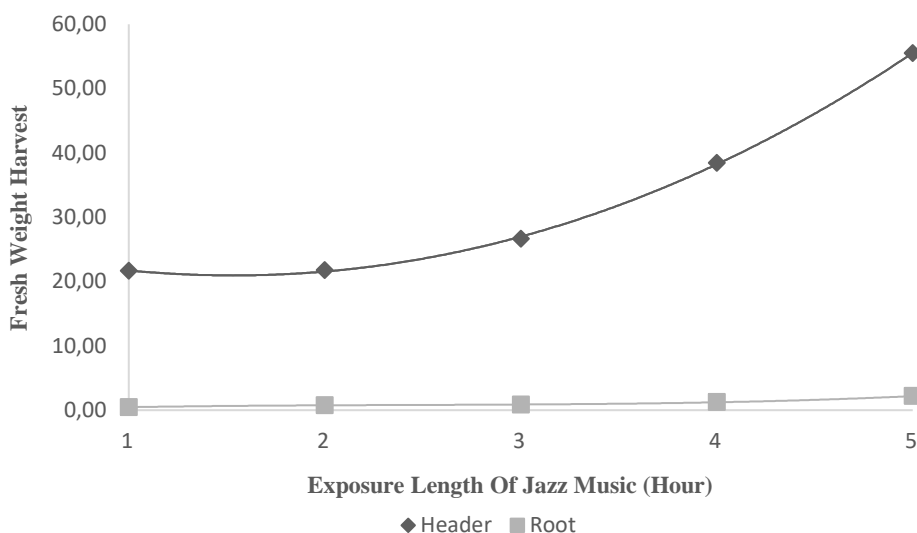


Figure 4. Fresh weight harvest graph of *pakcoy* at each treatment

The results of 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

Treatment	Fresh Weight Harvest (g)	
	Header (g)	Root (g)
P1	21.67a	0.46a
P2	21.78a	0.77a
P3	26.64a	0.86ab
P4	38.45b	1.24b
P5	55.49b	2.18c

Note: Different letters behind the numbers in the same column indicate significantly different values based on Duncan's test with a level of α 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 photosynthate. If the photosynthate 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 photosynthate 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.

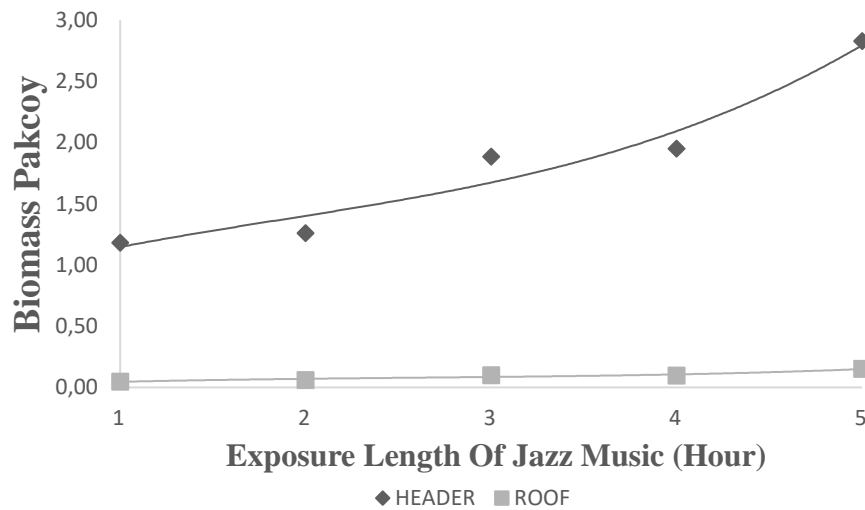


Figure 5. *Pakcoy* biomass of exposure length at each treatment

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

Treatment	Biomass (g)	
	Header (g)	Root (g)
P1	1.18a	0.05a
P2	1.26ab	0.06ab
P3	1.89bc	0.10ab
P4	1.95c	0.10b
P5	2.83d	0.15c

Note: Different letters behind the numbers in the same column indicate significantly different values based on Duncan's test with a level of α 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 photosynthate 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).

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