Effect of violin sound exposure with pressure level variation to green mustard (*Brassica juncea* L.) growth and productivity

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Abstract. The objective of this research was to investigate effect of violin sound exposure to morphology characteristic and green mustard productivity. Experimental design used was completely randomized design with one treatment factor which was sound level. The sound level consisted of three levels, 70-75 dB, 80-85 dB and 90-95 dB. Total treatment combinations were 4 combinations. The object of this research was Tosokan variety of green mustard which are commonly available in market. The number of samples was considered as repetition. Result showed that violin sound at level 70-75 dB resulted the highest germination rate about 98% when compared to 80-85 dB and 90-95 dB levels. Violin music sound stimulation gave significant effect on plant morphological characteristics such as plant height, leaf area and plant and root length when compared to the control plants. Sound exposure at 70-75 dB sound level generally produced highest values for all morphological characteristics. Statistical analysis showed that sound exposure at 70-75 dB sound level produced highest productivity average weight, 22.5 grams per plant, while control plants produced an average weight only 15 grams per plant. The conclusion of this study was violin music stimulation resulted increased green mustard productivity, especially at low sound level.

1. Introduction

Research on the effect of sound on plants has not been done much. The existing is research on sound exposure of a certain type which aims to increase plant growth and productivity. One of the technologies in order to improve plant quality is through the application of sonic bloom technology. Sonic bloom technology is a breakthrough technology aimed at making plants grow better. Sonic bloom utilizes high frequency sound waves which function to spur the opening of the leaf mouths (stomata) combined with nutrition [1]. Sound vibrations can affect the opening of leaf stomata to be wider [2], so that it can absorb more water and CO₂ and optimize the photosynthetic process, so that plant growth and productivity can be increased optimally. By opening the stomata wider, it means that the absorption of nutrients and other materials in the leaves is more when compared to plants without acoustic frequency treatment. The opening of the stomata causes oxygen gas O₂ to diffuse out and carbon dioxide gas CO₂ into the cells as a material for photosynthesis with the help of sunlight [3]. From the photosynthesis process, it will directly affect the respiration process, because the main ingredients of the respiration process are carbohydrates produced by the photosynthesis process. This respiration process will produce energy in the form of ATP (Adenosine Tri Phosphate).
This research examines the effect of exposure to sound waves with violin music and variations in sound levels on the growth and productivity of mustard greens. [4] have conducted research on the effect of gamelan sound on the productivity of mustard greens based on the duration of its exposure. The results obtained from this study were exposure to gamelan sounds for 3 hours increased the productivity of mustard greens when compared to the shorter duration and control plants. The reason behind the use of green mustard as an object of research is that it is easy to grow and responsive to environmental changes. Green mustard is often used as an experimental plant for fertilization, plant fertility, disturbances due to nutrient deficiency, and bioremediation [5]. According to research conducted by [6] on the effect of sound with a frequency of 0.3-6 kHz can significantly affect the height and width of rice leaves when compared to those without treatment. A similar study was also conducted by [7] who used sonic bloom technology on shallot plants which was concluded to increase productivity up to 2 tonnes/ha. However, empirically, research related to the effect of level and sound on plant growth and productivity has not been done much. From this research, it is hoped that the effect of violin music and sound levels on the growth and productivity of mustard greens can be seen.

2. Materials and methods

2.1. Materials and equipment
The equipment needed in this research include: Chamber/experimental box, tray, petri dish, plastic pot, Sound Level Meter type IEC651 Type2, active speaker, MP3 Player, ruler, preparations, digital scales, and a set of computers (personal computers) equipped with Adobe Audition 3.0 (Adobe Inc., USA) software as a sound file editor. The materials used in this study include: green mustard seeds of Tosokan variety, husk charcoal, compost and NPK compound fertilizer to provide the plant nutrients needed.

2.2. Methods
The sound used in this study is a digital file with mp3 format, classical music genre violin Canon D major Johann Pachelbel with a frequency range of 550-1200 Hz. The sound level consists of three levels, namely 70-75 dB, 80-85 dB and 90-95 dB. In addition, plants are also used as control plants. So that the total treatment combination is 4 combinations. Each treatment used 10 samples of mustard greens which were considered replications, so that the total plants used in the study were 40 plants.

2.3. Research implementation
The research implementation is divided into two types. The first is the germination phase and the second is the growth phase. In each phase, giving sound exposure is carried out for 3 hours every day starting at 7-10 AM (GMT+7). This treatment refers to research conducted by [4] where exposure to gamelan sounds with a duration of 3 hours resulted in higher productivity than exposure with a lower duration. The following is an explanation of each stage of the research.

2.3.1. Sound exposure. Green mustard seeds are planted on cotton in a petri dish and put into a chamber where there is an active speaker. The description of the frequency spectrum for the three types of sound presented can be seen in Figure 2. In this study, the measured frequency values were ignored and were
not included in the influencing variables, because the focus of this study was only on the type and level of sound used.

2.3.2. Nursery. The nursery is in the form of seedbed trays which are available in the market. The size of the trays used were 20 cm long and 8 cm wide for each treatment. The planting medium used was a mixture of husk charcoal and compost with a ratio of 1:1. Cotton are used as a growing medium for the germination phase which is placed in a petri dish.

![Figure 2. Frequency spectrum of violin music 550-1200 Hz.](image)

2.3.3. Transplanting. The transplanting process is carried out at the age of 14 days after seeding (DAS). Seedlings are transferred from the nursery medium to enlargement pots made of plastic material. The size of the planting pot is 10 cm in diameter and 15 cm high. The planting medium used was a mixture of husk charcoal and compost with a ratio of 1:1.

2.3.4. Maintenance. Plant maintenance carried out in this study includes embroidery, watering, and fertilizing. The embroidery process is the process of replacing dead plants with new plants. Stitching is done no later than 7 days after the transplanting process. Plants that are used to embroider are plants that have the same height or the lowest in one treatment. The watering process is carried out every day in the morning at 06.00-07.00 and evening at 16.00-17.00 with a volume of 200 ml/pot. The water used comes from groundwater in the research location. The fertilization process is carried out every 7 days using NPK pearl compound fertilizers available in the market. The dose of administration is 1 gram/pot which refers to research conducted by [4].

2.3.5. Harvesting. The harvesting process is carried out after 46 DAS or 32 days after planting, by removing all parts of the plant from the stem to the roots. After the harvesting process the wet weight of the plants is weighed.

2.4. Parameters observed
Parameters observed and measured in this study included germination, plant height, leaf area and plant productivity.

3. Results and discussion

3.1. Germination
The exposure of violin music at various sound levels in Figure 3 shows that the sound levels of 70-75 dB and 80-85 dB produce the highest germination power of 100% at the 36th hour, while the lowest is
found in mustard seeds without treatment (control) of 90% at the same time. The treatment graph in Figure 3 shows that the germination rate for all sound levels at the 6th to 18th hour is between 70-90% faster, when compared to the control. This is consistent with the research of [8], the sound of classical music accelerates germination. [9] stated that exposure to sound can stimulate enzyme activity in seed cotyledons so that they germinate more rapidly, in addition to other allegations that there is an increase in seed vigour which can increase the germination capacity of a plant. The energy propagation that accompanies sound vibrations greatly affects the various processes that take place in the germ cell related to its physiology. Research that has been conducted by [10] stated that exposure to sound with a frequency of 0.4 kHz at a sound level of 106 dB increased germination index, root growth activity and cell membrane penetration.

![Figure 3. Graph of time and germination relationship.](image)

3.2. Plant height

![Figure 4. Graph of the relationship between day and plant height.](image)
Plant height is the most frequently observed plant size both as an indicator of growth and as a parameter used to measure environmental effects or the treatment applied. This is done because plant height is the most easily seen measure of growth as a parameter of environmental influences. [3] stated that plant height is sensitive to environmental factors.

In Figure 4 it can be seen that at the beginning of growth between 4 days after seeding to 28 DAS, the sound level of 70-75 dB gave a higher plant height increase when compared to sound levels of 80-85 dB and 90-95 dB. The lowest plant height increase from 28 DAS to 46 DAS was found at sound levels of 90-95 dB and the highest increase in plant height was found at sound levels of 70-75 dB. From these data, there is a correlation that in violin music exposure, the lower the sound level results in the highest plant height. Abnormal conditions were seen on the 42nd day of observation, where the rate of increase in plant height was higher than usual. This is because on the 42nd to the 46th day the weather at the research location is rainy, thus reducing the daytime temperature to 27°C-30°C from 32°C-40°C initially. This condition causes mustard greens to grow optimally, where [5] observed that green mustard grows optimally at a temperature of 27 °C-32 °C during the day.

### 3.3. Leaf area

![Figure 5. Graph of the relationship between days and leaf area.](image)

Leaf area measurement is one of the morphological parameters commonly used to determine whether a plant grows well or not. Measurement started at 28 DAS when the 4th internode leaf had fully opened. Sound exposure treatment with different levels affected the leaf area at the three levels of sound presented. In Figure 5 it can be seen that the sound level of 80-85 dB gives a higher increase in leaf area. The results of this study are in accordance with the research conducted by [4] which shows that the sound of Javanese gamelan in the 3-6 kHz frequency range can increase the length and width of leaves of mustard greens (Brassica juncea L.). The results of a similar study were also stated by [11] where the sound of classical music for 3 hours increased the broad index of legumes. [12] stated that there was an increase in the area of tobacco leaves treated with sonic bloom by 3.28%. Observations on day 42 showed that there was a rapid increase in the area of mustard green leaves. The reason is same with the plant height situation.

### 3.4. Wet weight

Exposure to sound with violin music has an effect on increasing the biomass weight of mustard greens compared to control plants. In Figure 6, exposure to violin music with a level of 70-75 dB results in the highest biomass weight gain with an average of 22.56 grams per plant. The control plants produced an
average wet weight of 14.67 grams of mustard per plant. The results of this study are consistent with research conducted by [12] stated that the application of sonic boom was able to increase tobacco production by 31.9% or 581 kg / ha, from 1822 kg / ha to 2403 kg / ha. Similar results were also stated by [13] who conducted a study using a natural sound stimulus with a frequency of 40-2000 Hz for 3 hours starting at 09 AM on strawberry plants, can increase the amount of fruit production by 16.6% and the total biomass by up to 50%. There is a tendency on violin music exposure that the lower the sound level, the higher the wet weight of green mustard. In general, the exposure to violin music gives a significant effect when compared to the control plants.

Figure 6. Graph of the relationship between sound level and wet weight.

4. Conclusions
Exposure to violin music increased germination, where violin music produced the largest percentage of germination, namely 98% when compared to control, which was 90%. Violin music stimulation affects plant morphological factors including plant height, leaf area and green mustard productivity. The analysis of the measurement results shows that exposure to violin music has a significant effect on the productivity of mustard greens. Exposure to violin music can increase the wet weight of green mustard by 57.14% compared to those without sound exposure (control).

References
[1] Mulyadi 2005 Pengaruh teknologi pemupukan bersama gelombang bunyi (sonic boom) terhadap perkecambahan dan pertumbuhan semai Acacia mangium Wild [Effect of fertilization technology with sound waves (sonic boom) on germination and growth of Acacia mangium Wild seedlings] Jurnal Manajemen Hutan Tropika 11 1 pp 67-75
[2] Kadarisman N and Purwanto A 2011 Rancang bangun audio organic growth system (aogs) melalui spesifikasi spektrum bunyi binatang alamiah sebagai local genius untuk peningkatan kualitas dan produktivitas tanaman holistikulture [Design of audio organic growth system (AOGS) through the specification of the sound spectrum of natural animals as a local genius to improve the quality and productivity of horticultural plants] Prosiding Seminar Nasional Penelitian, Pendidikan dan Penerapan MIPA-UNY pp 463-74
[3] Sitompul S and Guritno B 1995 Analisis pertumbuhan tanaman [Analysis of plant growth] (Yogyakarta: Gadjah Mada University Press)
[4] Susanti T and Rondowunu F 2013 Pengaruh musik pada range 3000-6000 Hz terhadap pertumbuhan sawi hijau [Effect of music in the 3000-6000 Hz range on the growth of mustard greens] Jurnal Program Studi Fisika Universitas Kristen Satya Wacana Salatiga 1 pp 1-15
[5] Francisca S 2009 Respon pertumbuhan dan produksi sawi (Brassica juncea) terhadap penggunaan pupuk kascing dan pupuk organik cair [The response of growth and production of mustard greens (Brassica juncea) to the use of vermicompost fertilizers and liquid organic fertilizers] Undergraduate Thesis (Medan (ID): Universitas Sumatera Utara)

[6] Yu S, Jiang S, Zhu L, Zhang J and Jin Q 2013 Effects of acoustic frequency technology on rice growth, yield and quality Transactions of the Chinese Society of Agricultural Engineering 29 pp 145-6

[7] Yulianto 2008 Pengkajian dan pengembangan teknologi gelombang bunyi dan nutrisi rumput laut pada cabai merah (Capsium annum L.) [Assessment and development of sound wave technology and nutrition of seaweed in red chilies (Capsium annum L.)] Agroland 15 1 pp 1 – 6

[8] Creath K and Schwartz GE 2004 Measuring effects of music, noise, and healing energy using a seed germination bioassay The Journal of Alternative and Complementary Medicine 10 pp 113-22

[9] Mareza M, Podesta F and Ratibayati 2009 Respon Perkecambahan Lima Varietas Padi Rawa Lebak terhadap Pemberian Zat Pengatur Tumbuh 2,4-D pada Fase Vegetatif [Germination Response of Five Swamp Rice Varieties to Giving Growth Regulators 2,4-D in the Vegetative Phase] Akta Agrosia 12 2 pp 177-83

[10] Wang B, Chen X, Wang Z, Fu Q and Zhou H 2003 Biological effect of sound field stimulation on paddy rice seeds Colloids and surfaces 15 pp 29-34

[11] Singh A, Chatterjee J and Jalan A 2013 Effect of sound on plant growth Asian Journal of Plant Science and Research 3 4 pp 28-30

[12] Iriani E, Yulianto and Choliq A 2005 Penerapan teknologi sonic bloom pada tembakau di Kabupaten Kendal [Application of sonic bloom technology to tobacco in Kendal Regency] Prosiding Implementasi Hasil Pengembangan Pertanian BPTP Jawa Tengah

[13] Lirong Q, Guanghui T, Tianzhen H, Baoying Z and Liu X 2010 Influence of sound wave stimulation on the growth of strawberry in sunlight greenhouse IFIP AICT 317 pp 449-54