Effect of sonic bloom frequency on the growth of red amaranth (Alternanthera amoena Voss)

B Susilo and Y F Fitriani

Department of Agricultural Engineering, Faculty of Agricultural Technology, Universitas Brawijaya, Malang, Indonesia

Email: susilo@ub.ac.id

Abstract. Red amaranth (Alternanthera amoena Voss) is able to be used not only as food plants but also as herbal plants. Due to a high nutrient content of red amaranth, the demand of this plant is continue to increase. Even though this plant has high demand, its productivity is relatively low. The Sonic-bloom was experimented to be applied on the red amaranth cultivation to improve the productivity. The purpose of this research is to determine the effect of various frequencies and duration of sonic-bloom exposure on the growth of the red amaranth plant (Alternanthera amoena Voss). The frequencies were set at two levels i.e. 3000-5000Hz and 7000-9000 Hz with the exposure duration were 15, 30, 45, 60 and 75 minutes respectively. The results showed that the frequency and duration of exposure have a significant influence on the cultivation parameters of red amaranth plants. Frequency treatment of 3000-5000 Hz and 7000-9000 Hz produced plants with 25.93 cm and 18.83 cm of height, 13 strands of leaves, 42 cm and 30.6 cm of plants length, 2841.01 μm² and 3688.51 μm² of stomata area, and 14.84 gr and 7.58 gr of wet plant weight respectively. These results were significantly different compared to the control (without sonic bloom treatment) that have 8.53 cm of height, 7-13 strands of leaves, 14.87 cm of plants length, 972.98 μm² of stomata area, and 0.55 gr of wet weight. The best treatment in this study is the frequency of 3000-5000 Hz with exposure duration of 75 minutes, concluding that Sonic Bloom technology is able to improve the productivity of red amaranth plants.

1. Introduction

Sonic bloom is an organic technology that can stimulate plant growth through the application of music frequencies and providing of plant nutrition. This treatment is able to stimulate plant cells to absorb nutrition more effective [1]. Sonic Bloom can be applied to all types of plants from annual crops such as rice, crops, flowers and perennial plants such as coffee, cocoa, rubber, palm oil, teak, and so on. Each plant has specific frequency for up-taking of nutrition [2].

Red Spinach (Amaranthus spp.) is promoted widely as vegetables and as source of nutrition for residents in developing countries. The energy content of red spinach is 55 kcal/100 g better than that of green spinach which only have 15 kcal/100 g. Anthocyanin is a purple red pigment that makes the spinach leaves have red color. This compound is able to prevent oxidation of free radicals that cause various diseases [3]. The Sonic-bloom was experimented in this research to be applied on the red
amaranth cultivation to improve the productivity. The purpose of this research is to determine the effect of various frequencies and duration of sonic-bloom exposure on the growth of the red amaranth plant (*Alternanthera amoena* Voss).

2. **Materials and Method**

Research was carried out by assembling a set of sonic bloom and preparing the red amaranth seedbed in the planting medium in the laboratory of the laboratory of Mechatronic and Agricultural Machinery, Department of Agricultural Engineering, Universitas Brawijaya from June to July 2019.

Rockwool was prepared as growing media for seeding the red amaranth. Rockwool was cut in small cubes, arranged in a seedling tray and kept in wet condition. The seeds were germinated on rockwool for 10 days and then transplanted to the polybag of 15 cm diameter with planting media. The planting media were a mixture of soil, organic fertilizer, and rice husk with a ratio of 1: 1: 1. Liquid fertilizer was sprayed with appropriate dose and weeding was carried out manually.

The number of leaves and plant height were measured every three days, while the area of stomata opening was observed on days 15 and 30. Measurement of the stomata area was conducted with a microscope that was interfaced with computer. Software of DX-Olympus was used to measure length and wide of stomata. Plants are harvested at the age of 30 days and then measured the length of the plant i.e. the length from the root tip to the longest leaf. Each plant is weighed to measure the wet mass of plants.

Relative humidity, ambient temperature and light intensity were observed. The Environmental parameters are measured in the morning and evening. The level of environmental noise both in the control treatment and in the experimental treatment was measured routinely as well.

3. **Results and Discussion**

The range of Relative Humidity (RH), temperature and light intensity during experiments are in the range of 40-50%, 28-32 °C and 23000-27000 lux respectively. The level of environmental noise in the control treatment was 68-76 dB and in the experimental treatment was 55-57 dB.

3.1. **Plant height**

Plant height was measured from ground level to the highest end of the plant. The highest plants were 27.05 cm by the treatment of sonic bloom with a frequency of 3000-5000 Hz with exposure time of 60 minutes. It was extremely height compare to the control that only produce 8.95 cm plant height and 17.25 cm produced by treatment of 7000-9000 Hz frequency and exposure time of 75 minutes. This result was in line with the research conducted by Utami et al. [4] that the treatment of classical and hard rock music has a significant effect on the growth of chili. Figure 1 shows the effect of music frequency on the height of the red amaranth plants.

![Figure 1. Effect of music frequency on plant height of ret amaranth.](image-url)
Figure 1 shows that the treatment of 3000-5000 Hz improves the growth of red amaranth compared to the controls (without treatment). But, it was not as high as that of from the frequency of 7000-9000 Hz. These results are consistent with the results of the research conducted by Bahtiar et al. [5] that the treatment of 4 kHz has effect on growth of rice seed. Sonic bloom technology and organic fertilizer can be applied simultaneously to improve onions productivity [6]. It means that the treatment of specific frequency effects on the growth of rice seed, but also effects on others plants grow include the red amaranth.

3.2. Numbers of leaves

The amaranth with treatment of 7000-9000 Hz frequency and 60 minutes exposure has the most leaves, which are 16 leaves as in Figure 2. It is more leaves compared with the other exposure time at the same frequency and also the treatment of 3000-5000 Hz for all exposure time. The control treatment produced only 7 leaves, while the treatment with frequency produced leaves in the range of 8 to 16 strands or 11 strands average. This data shows that the sonic bloom frequency effects on the production of leaves number. This result is appropriate with A’mallina and Astono [7], stating that grasshopper makes a sound that can increase the productivity of peanut plants. It is possible because the frequency of grasshopper sound is in the range of 7000 Hz.

![Figure 2. Effect of sound frequency on the leaves number of red amaranths.](image)

3.3. Length of plant

Similar to the effect on other variable, the sonic bloom frequency has significant effects on the length of plants. Frequency of 3000-5000 Hz and exposure of 60 minutes stimulate the growth of the red amaranth. The plant length of 46.9 cm can be produced at the frequency treatment and the exposure time. This treatment produces three times compared to the control treatment that only produce plants length of 16 cm.

The red amaranth treated with frequency show average size longer than plants without treatment. These results are consistent with the results of the study conducted by Prasetyo et al. [8]. They applied sonic frequency to improve the productivity of green spinach. The sonic bloom frequency also had positive effect on the growth of red amaranth.

Figure 3 shows the effect of sound frequency on the length of red amaranth. Both of low frequency and high frequency produce red amaranth longer than that red amaranth without frequency treatment. Frequency has positive effect on growth parameter, because it has a relation with plant metabolism. It can stimulate gas exchange through openings of stomata.
3.4. Area of stomata

The opening areas of stomata are showed in Figure 4. The largest opening area of stomata occurs in the frequency of 7000-9000 Hz and exposure of 75 minutes. It was 3688.51 μm². The smallest opening area occurs in the frequency of 3000-5000 Hz and exposure of 30 minutes, but it was still larger than opening area of control treatment i.e. 972.98 μm². Application of sonic bloom frequency was able to increase opening area between 1.7-2.7 times to the area of the control treatment.

![Figure 3. Effect of frequency and exposure time on length of red amaranth](image)

![Figure 4. Effect of frequency and exposure on the opening area of stomata](image)
This result was matching with the research carried out by Aditya et al. [9], that music frequencies of 6000–9600 Hz open the stomata of mustard larger than the normal. The application of frequency has effect on the opening area of stomata.

Identical research has been carried out by Widiastuti [10]. Application of frequency of 3000 Hz on corn plant opens the stomata larger than normal condition and application of other frequency. The consequence of the larger stomata area results the smoothness of carbon dioxide mobility for photosynthesis. The exposure of the insect sound manipulated at peak frequencies of 3500 Hz could affect the area of stomata opening [11]. It has effect on the plant height, number of stems, and mass of yields on rice plants. It is logic that the sound treatments in this research increase the growth of red amaranth plants through the opening of stomata.

Figure 5 shows the dimension of stomata captured with microscope that is interfaced with computer. The shape of the stomata is ellipse. The dimension is showed by the size of long axis and short axis.

![Figure 5](image)

**Figure 5.** Opening of stomata (a) control, (b) frequency of 3000-5000 Hz, (c) frequency of 7000-9000 Hz

### 3.5. Wet mass

The red amaranth plant was weighed with analytical scales after harvesting. The control treatment produced average weight of 0.4 g for each plant. This result is much smaller compared to the results of the sonic bloom treatment. The treatment of 3000-5000 Hz and exposure of 15 minutes, 30 minutes, 45 minutes, 60 minutes, and 75 minutes produce 9.96g, 3.62 g, 4.92 g, 12.78 g and 17.93 g respectively.

It is interesting that high frequency treatment results wet mass smaller than that of low frequencies treatment as shown in Figure 6. Frequency treatment of 7000-9000 Hz with exposure time of 15 minutes, 30 minutes, 45 minutes, 60 minutes, and 75 minutes respectively produce 3.67 g, 3.17 g, 3.22 g, 2.19 g, and 5.79 g wet mass. This wet mass is bigger than the wet mass without frequency treatment, but lower than that medium frequency. Although frequency treatment affects wet mass growth, there is an optimum frequency that must be applied to get maximum results. It means that the frequency is not directly proportional with the mass growth of the red amaranth.
The research conducted by [8] shows also that the wet mass of green mustard plants with frequency treatment have bigger than that without frequency treatment. The optimum frequency is on the range of 3000 Hz. Experiments show that the optimal frequency range for red amaranth plants is also similar to the optimum frequency range for mustard greens.

The application of sound frequency in general improves the wet mass of plants. Anas and Kadarisman [11] conducted this research on rice plants and shows that the wet mass of rice with sound frequency was better than that without treatment. They use a kind of insect for generating sound frequency. A frequency of 6000-9000 Hz was applied to improve production of mustards plant [9].

4. Conclusions
Sonic bloom with specific frequency can be applied to improve the growth of red amaranth. All of plant growth parameter i.e. plant height, number of leaves, plant length, stomata area, and wet mass increase significantly after sonic bloom applied. The optimum frequency of sonic bloom was 3000-5000 Hz for the best growth of red amaranth. The optimum exposure time of sonic bloom was 75 minutes.

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