MINI REVIEW

Response of Music Towards Ornamental Plants – A Review

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Abstract

Music can trigger a range of emotions in humans and other animals. It also has some beneficial effects on plant growth. Music is regarded as one of the triggers to which plants are known to respond. Plants respond to different types of music. They grow well when exposed to certain kinds of music, whereas there may have stunted growth with another type of music. This may differ depending on the kind of plant species also. It could be said that noise inhibited plant growth and development, whereas music encouraged it, even germination. Certain audible and musical frequencies aid the plant in improving physiological processes, including nutrient absorption, increased protein content, etc. This is evident in the plant's growth in terms of height, number of leaves, and general development and health. Some scientific researchers have proved that the growth of plants can be influenced by music and the farmers can use this for better growth of plants.

Keywords: Development, Emotions, Frequencies, Growth, Music.

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Introduction

Sound and silence serve as the medium for the art form of music. Through the use of the components of rhythm, melody, harmony and colour which creates brilliance of expression and emotion in meaningful form. Music is sound and wave is the highest form of sound. It is structured sound produced by instruments or human voices. Plants can breathe and grow because they are living things. The ability to respond to incentives is one of life's strengths. When testing experimental treatments on sensitive creatures, complex multicellular organisms like plants are compared to humans. It is well-documented to have an impact on plant growth. In addition to accelerating growth, music clearly impacts the concentration of several metabolites, such as chlorophyll, carbohydrates, protein, *etc.* Plants adore music and will respond depending on the type of music and its wavelength. Conversing with humans has been shown to help plants grow and develop more effectively. Though little work has been accomplished in this field where plants are exposed to various types of sound and the results are tracked and analyzed. When studying the impact of several musical genres on plants in 1968, Dorothy Retallack discovered that plants grow well when exposed to classical music, whereas plants wither when exposed to rock music. Following these discoveries, the concept of music's impact on plants was developed. A variety of frequencies and vibrations are mixed together in music in a harmonious and coherent way. It has long been held that loud, discordant noises might affect a plant's mood, health and flowers. Soft, rhythmic music is better for a plant's growth and blooming, which might affect a plant's general health and speed of growth. On the other side, some reports claim that particular musical genres can negatively impact plants, which may harm plant growth. Heavy metal music can be extremely harmful to a delicate plant even when played at low intensity.

History

Sir Jagdish Chandra Bose (1902) an Indian plant physiologist was one of the pioneers to investigate how environment and music affect the plants and asserted that plants respond to the attitude with which they have been raised and are sensitive to their surroundings, including light, cold, heat, and noise, just like people are. His publications "Response in the Living and Non-Living," published in 1902 and "The Nervous Mechanism of Plants," published in 1926 provide documentation.

Joel Sternheimer (1943) developed a model tune for chalcone synthase in tomato.

Dan Carlson invented the Sonic Bloom system during the year 1960.

Dr. T. C. Singh (1962) an Indian scientist and botanist, discovered that when exposed to music, balsam plants grew 72% more biomass and 20% higher. Additionally, he discovered that petunias and marigolds flowered two weeks earlier than expected due to vibrations from Bhartnatyam. He also observed many changes of plants' physiological and biochemical properties, i.e., increase in growth, metabolism, no. of stomata, increased transpiration and photosynthesis, etc.

Dorothy Retallack (1973) was a student of professor Francis Brown. She conducted detailed research on effect of music on plants and concluded continuous rock music could kill the plants. In her book "The sound of music and plants" she revealed the entire study and its findings.

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How Can Plants Hear?

Mechanoreceptor

It is something in human ear that help us to detect and distinguish sound waves and help us hear music and other sounds. The effect of music on plants is unclear though some people say that if plants have mechanoreceptors, they can also change the sound waves, like those from music. It also responds to pressure.

The pressure from the sound wave causes the medium to vibrate as it travels through a medium like air or water which is how sound is transferred. The plants might pick up on this vibration. Although plants cannot hear music, they can feel its vibration, which causes the protoplasm in their cells to move more quickly. As a result of this stimulation, the plant's system may work better, producing more nutrients, resulting in stronger and better plants.

Sound Production and Perception in Plants

Fig. 1(A) depicts the sound production by plants. Plants also produce vibrational sound through their xylem. The reason that xylem serves as a means of transferring water in plants. In the xylem, transpiration and rehydration occurred. The stress brought on by transpiration eventually leads to the formation of vapor bubbles (cavitation) in the xylem vessels. There is no doubt that gas bubbles attached to plant vessels can also emit sound. Long held theories hold that audible sound is generated when transpiration is decreased, while ultrasonic emission is emitted when transpiration is enhanced. Additionally, sound vibration is produced as the diameter of the xylem artery shrinks.

Fig. 1(B) indicates the sound perception by plants, despite the fact that nothing is obviously different. In plants that have been subjected to sound vibration, transcriptional and translational alterations have occurred. In plants exposed to sound, there are changes in the level of transcripts associated to defence and redox homeostasis sensitive to mechanical stimuli. Whether organs or proteins are specifically responsible for hearing has not yet been known.

According to Fig. 2, artificial sound treatments can have a wide range of impacts on plants in the following ways.

Improvement of seed germination and growth

By changing the plant growth hormone-like Indole-3 acetic acid (IAA) and gibberellins, sound promotes plant development.

Induction of plant defence response against pathogens

Through the activation of the plant defence hormone, such as salicylic acid (SA) and jasmonic acid (JA), sound pre-treatment

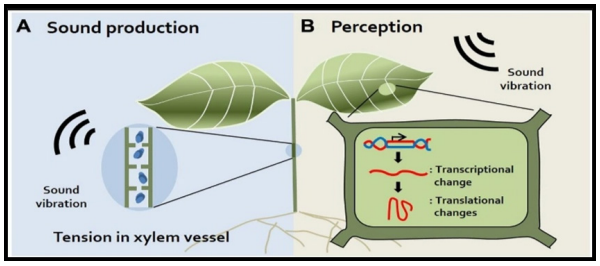

Fig. 1: Sound-evoked physiological reaction in plants (Source: https://www.frontiersin.org/)

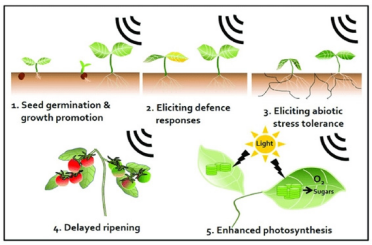

Fig. 2: Sound wave as a plant stimulant and protectant (Source: https://www.frontiersin.org/)

increases plant immunity against ensuing pathogen attack.

Eliciting Abiotic Stress Tolerance

Sound therapy may increase a plant's ability to endure drought by altering the cell wall's suppleness and flexibility, affecting the plant's capacity to absorb more water.

Delaying Ripening

The maturity of tomato fruits can be halted by sound treatments. By inhibiting the manufacture of ethylene and the expression of genes associated to signaling, ethylene production may be postponed.

Enhancement of Photosynthetic Capacity

The use of sound therapy increases the expression of genes involved in photosynthesis, including those that produce fructose 1,6-bisphosphate aldose and rubisco small subunit, which might lead to the fixation of CO_2.

Music Effect on the Development of Plants

Gene activation

Certain gene is activated by a specific sound frequency which improves plant cell growth.

Effect on stomata

Sound frequency technology stimulate leaf stomata to open, thereby, the plants will be able to increase its uptake of spray fertilizer and dew.

Effect on cell organelles

Specific frequencies induce resonance in the cell organelles of living organisms, which stimulates cell development by increasing the mobility of cytoplasm inside the cell.

Plant hormone

In response to sound, the plant hormone gibberellic acid lengthens shoots or initiates seed germination.

Movement of protoplasm

The sound causes the leaves to vibrate and intensify this movement, accelerating the synthesis of food and nutrients and promoting healthy plants' growth.

The Impact of Various Musical Genres on Plants

Various types of music effects differently to plants growth. The frequency of sound also influences the growth of plant. Classical music may promote better, bushier, greener, and healthier plant growth; Jazz music may speed up growth and make plants grow

more fully. Plant mass and fruit flavor are increased by heavy metal music infused with new age and Celtic music; The growth of plant is unaffected with country and western music; plants suffer from loud rock music.

Marigold plants are exposed to three types of music *i.e.,* Indian music, meditation music and noise, and control (without music). At first, similar growth patterns were observed, but during the following fortnight, plants exposed to meditation music and soothing Indian music outgrew noise therapy in terms of growth and flowering (Chaudhary and Gupta, 2015).

Frequency of Sound

The germination of seeds, the lengthening of roots, the height of plants, and other biological indices of plants can all be positively impacted by specific frequencies and intensities. The plant thrives when listening to music between 115 Hz to 250 Hz. Plants acquire audio acoustic emissions between 10-240 Hz in addition to ultrasonic acoustic emissions (UAE) between 20 and 300 kHz. When roots are exposed to continuous 220 Hz sound and then start growing in the direction of the excitation frequency, this provides confirmation of the existence of plant mechanosensory abilities. According to Dan Carlson, a medley of frequencies between 3000–5000 kHz can open up the stomata of plants more quicker.

In chrysanthemum callus, the activity of superoxide dismutase (SOD) enhanced with rising sound intensity (100 dB) and frequency (800 Hz), while it declined below that range (Liu *et al.,* 2002). In *Dendrobium candidum*, SOD, catalase activity (CAT), peroxidase activity (POD), ascorbate peroxidase activity (APX) and malondialdehyde (MDA) content of leaves, stems and roots stimulated by sound wave with certain intensity (100 db) and frequency (1000 Hz) were elevated at variable degrees below the stress and improved averagely than the control group (Li *et al.*, 2008). *Salvia splendens* cv. Vista's biochemical content and activities, such as protein content, catalase activity (CAT), peroxidase activity (POD), and malondialdehyde (MDA) content, were at their peak when exposed to sound waves for a month at a frequency of 1000 Hz at 110 dB intensity for an hour each day. Additionally, with an increase in intensity to 110 dB in 1000 Hz frequency, stem length, root length, shoot weight, and shoot dry weight all showed a greater extent in comparison to the control (Heidari *et al.*, 2020).

Effect of Different Length of Music on Plants

In an experiment by Dorothy Retallack in 1973, she exposed three groups of plants to various lengths of music. In one group she played note F for 3 hours a day and in another group, she played alike note for 8 hours a day and 3rd group remained in silent as control. The results showed that the plants in the first group, which was exposed to 3 hours a day, grew twice as large and were twice as healthy as those in music-free environments. The second group the plants died when exposed to music by 8 hours a day within two weeks of the experimental beginning.

Chivukula and Ramaswamy (2014) found that rose plants subjected to vedic chants for 60 minutes every morning for 62 days grew taller and produced more flowers with the largest diameter than plants that were not exposed to the music. When plants like *Tagetes erecta*, *Catharanthus roseus*, and *Dendranthema grandiflorum* were subjected to 3 hours per day of gentle music for a month, the number of leaves, flowers, and early flower buds appeared enhanced compared to the control. Additionally, treated ornamental plants had higher carbohydrate, protein, and phenol concentrations than control plants (Sharma *et al*., 2015).

Table 1: Response of music on different plants

Sr. No.	*Plants*	*References*
1	Chrysanthemum	Xiujuan et al (2003) Yi *et al.* (2003) Wang *et al.* (2004) Wang *et al.* (2003)
2	Dendrobium	Li *et al.* (2006)
3	Alocasia	Hou *et al.* (1994)
4	Salvia officinalis	Rahman (2017)
5	Balsam	Collins and Foreman (2001)
6	Phaseolus vulgaris	Singh *et al.* (2013)
7	Strawberry	Qi *et al.* (2010)
8	Cucumber and cabbage	Qin *et al.* (2003)
9	Tomato, lettuce, spinach	Meng *et al.* (2012)
10	Kiwi	Xiaocheng *et al.* (2003)

Positive and Negative Impact of Music

Various types of music affect differently in that some has a positive effect and some has negative effects. Plants grow faster when they are exposed to music and there is less pest disease infection and influence the various metabolites concentration. It can be used as a component for getting higher yield with good quality. Continuous playing of music causes noise pollution for both animals and human. The pressure level of sound is inversely proportional to the distance, so the bigger the area, the lower the intensity. Still there is much confusion and contradictions about this technology in terms of frequency and exposure time periods, which may lead to stunted plant growth. Scientists have conducted the experiment using different sound frequency which are listed below in the table 1.

Conclusion

From the literature it is clear that music has an impact on plant growth. The SOD activity in the chrysanthemum callus was increased by sound at an intensity and frequency of 100 dB and 800 Hz, respectively. Inducing peroxidation and boosting antioxidant enzyme activity in *Dendrobium candidum* through sound stress aids in diminishing the formation of active oxygen species (AOS) and, as a result, guards plant cells from oxidative damage. The growth and blossoms of the rose were aided by Vedic chanting for 60 minutes to 62 days. Marigold plants develop more healthily to the sounds of light Indian music and meditation music. A month of listening to soothing music positively impacted the growth of several ornamental plants, including *Tagetes erecta*, *Catharanthus roseus*, and *Dendranthema grandiflorum*, as well as biochemical content. Sound therapy at 1000 Hz frequency and 110 dB intensity with a one-hour daily basis was proven to promote high MDA content and antioxidant enzyme activities with quick vegetative development in *Salvia splendens*.

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