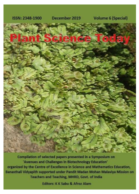
Plant Science Today (2019) 6(sp1): 639-644
https://doi.org/10.14719/pst.2019.6.sp1.677

HePG

ISSN: 2348-1900

Plant Science Today

http://www.plantsciencetoday.online



OPEN ACCESS

Review Article

Impact of different musical nodes and vibrations on plant development

Priya Singh[1], Nidhi Srivastava[1], Neha Joshi[2] & Ina Shastri[2*]

[1]Department of Bioscience and Biotechnology, Banasthali Vidyapith, Rajasthan, India
[2]Department of Music, Banasthali Vidyapith, Rajasthan, India

Article history

Received: 27 November 2019
Accepted: 26 December 2019
Published: 31 December 2019

Publisher

Horizon e-Publishing Group

****Correspondence***

Ina Shastri
✉ Ina_shastri@yaaho.com

Abstract

The effects of ambient environmental factors on physiological attributes of plants have been explored extensively. Among all the factors, impact of sound on the plants is an interesting aspect to study. This review attempts to comprehend the impact of sound waves on the development and behaviour of the plants. Musical nodes with healing energy have a certain impact on seeds germination. This can enhance overall plant health by improving growth and resistance, beyond chemical triggers. In past, seed growth and germination behaviour, influenced by different pre-treatments has been studied for different plants. This review is an effort to provide an indication of the recent results, constraints, and prospective applications of sound wave therapy as a physical trigger for modulating physiological characteristics and giving plants an adaptive benefit. Sound wave therapy is now emerging as a fresh promotion for protecting crops from harmful circumstances and maintaining plant fitness.

Keywords: Frequency; Development; Growth; Physiology; Music; Sound; treatment.

Citation: Singh P, Srivastava N, Joshi N, Shastri I. Impact of different musical nodes and vibrations on plant development. Plant Science Today 2019;6(sp1):639-644. https://doi.org/10.14719/pst.2019.6.sp1.677

Indexing: Plant Science Today is covered by Scopus, Web of Science, BIOSIS Previews, ESCI, CAS, AGRIS, UGC-CARE, CABI, Google Scholar, etc. Full list at http://www.plantsciencetoday.online

Introduction

Plants develop physiological and developmental changes against environmental difficulties. It is known that plants react to stimuli and music is regarded as one. Music vibrations, in diverse form of sounds are known to influence plants flowering, nutritional status and also basis of extreme variation in its metabolism (1). In fact, plants derive pleasure from music and also play with it. Plants feel delighted under the influence of music patterns as their biological motions are affected. Though, sometimes plants may also get adversely affected and their plant tissues may get injured under the stress of music (2). Plant tissues get relaxed by gentle vibrations of light music (3).

It has been noted that different types of sounds influence plant health differently. Many scientists have also suggested that the impact of acoustic frequency on plant growth patterns consists of distinct music (4). In other words, particular audible frequencies or distinct musical frequencies promote better physiological procedures such as nutrient absorption, photosynthesis response, protein synthesis, etc., as well as general growth and healthier crops including enhanced height and larger leaves (5).

Music, however, is a harmonious and articulate mixture of numerous frequencies and vibrations with distinct shapes, characteristics and pitches. According to researchers a plant's mood and health could be ruined by loud and unpleasant sounds. On the other hand, pleasant and soft rhythmic music would be better for their growth and blossoms. Thus, these effects of sound may increase the plant size, growth rate and also influence their overall health (6).

Here, we are dealing with two circumstances that are compulsory for sound wave generation and circulation, where a vibration frequency disturbance between 20 Hz and 20000 Hz is the audible frequency range. The various types of speed, pitch, loudness and timber characteristics of sound waves have become increasingly common in use for the purpose of plant growth and development and more attention has been paid on the material of environmental stress created by specific music. However, there are many issues, confusions and contradictions. Some researchers are using various music styles for crops, such as rock, jazz, classical or light music and drew different outcomes, while others used additional types of sound frequencies and sound pressure (7).

As a result, it proves that, sound stimulation could enhance resistance to diseases and decrease chemical compost and biocide requirements (8). On the other hand, the sound effect structure and method have not yet been disclosed. It was also indicated that under sound stimuli some stress-induced genes could be turned on and the transcription rate could be improved (9). Treatment of plant acoustic frequency technology with various stages of the plant exposed to different music can be used. The biological activities of the plant under the influence of different types of music have been mentioned (Fig. 1).

The effect of music on growth and germination

In the vast area of agricultural sciences, number of studies have shown the role and vital impact of music on plant growth, hence improving yield and minimizing the use of fertilizers. Plants are sensitive to different types of waves. The studies already suggested that sound wave (SVs) with different frequencies can accelerate the growth and development of plants. Individual category of plants reacts to the particular sequence of musical notes with different sound waves to stimulate growth (10).

Salvia officinalis L. plant was selected for classical music which resulted into significantly stimulated number of branches per plant and increased height of plant in the addition to fresh and dry weight (11). Musical waves as a therapeutic energy, have a significant impact on growth and germination of plants (12).

Cowpea (*Vigna unguiculata* (L.) Walp.) is recognized for drought hardy nature; this plant is extremely adaptive to high temperatures and drought than other species (12). Six different types of music (Natural, classical, traditional, techno, noise, traffic generated) exhibiting different types of significant impact on its traits. Under classical music, traits of cowpea, i.e. grain yield in single plants (33%), stomatal conductivity (21%), leaf relative water content (21%), chlorophyll (47%), single plant leaf region (30%), plant height (38%), sub-branches (52%), gibberellins hormones (81%); nitrogen (44%) and calcium (21%) enhanced while some characteristics, i.e. proline (31%), abscisic acid hormone (2%) were compact to regulate (12).

Sound waves also influenced the growth of Chrysanthemum (*Gerbera jamesonii* Bolus ex Hook.) seedling by reflecting its cell cycle. Sound stimulus can also accelerate Chrysanthemum callus development. It was also noted that the content of chlorophyll, proline and soluble protein was remarkably enhanced after therapy under the gradient magnetic field and SOD activity increased significantly, while membrane permeability and POD activity were decreased (13). There are reports on the biological impact of sound waves on paddy plants showed that the germination index and stem height increased the new weight level relatively ($P<0.01$); roots system activity and cell membrane penetrability ($P<0.01$) improved considerably at 0.4 kHz and 106 db SPL sound wave frequencies (15, 16). Paddy seeds development also improved when the stimulation of the sound wave surpassed 4 kHz or 111 dB.

Sound wave effects on kiwi (*Actinidia chinensis* A. Chev.) fruit resulted in highly rich vitamin C, vitamin E, sugar levels and enhanced root activity and number of roots; the permeability of cell membrane was reduced (14). With a significant difference on the *A. chinensis,* plantlets had dual effect from sound waves on the root development. Sound waves here have enhanced root activity and improved number of roots, but the permeability of cell membranes has been reduced (15).

Recent proposal showed that the frequency of the youthful root tips of *Zea mays* between 0.2 and 0.3 kHz was obviously bending towards a constant source of sound and whole measuring the elevated proportion of bending (16).

Plants are very sensitive. Hence, mostly the impact of light and soft music improves growth and yield. Soft music with light wave has gentle vibrations that relax the plant tissues (17). Violin music also significantly increases plant growth. Mild music vibration helps the crops to grow quickly and become stronger (18). This type of work could be useful in increasing crop production for the farmers (19).

ISSN: 2348-1900

Photosynthetic response under the effect of sound wave

PAFT (Plant Acoustic Frequency Technology) seeks to introduce impose unique frequency sound waves that are plant compatible with plant meridian systems in order to boost plant output and reduce fertilizer usage (20). Sound wave treated strawberries grew-up stronger with deeper green leaves, flowering and fruition. Strawberries have been improved with resistance to diseases and insects, with a slight impact on yield (21). It also concluded that acoustic frequency therapy could enhance photosystem reaction centre activity, increase photosystem electron transportation and photochemical effectiveness.

In addition, the absorption capacity of light energy improved significantly by sound waves; the result is more electron transport between original quinine receptors on the receiving side of PS II, more light energy for photochemical response and last but not the least, less superfluous energy for excitation (22).

Effects of sound and music on enhancement of the plant immune system

Growth in the world's population poses a challenge to explore opportunities to use fresh and organic technologies to boost up food production. Hence, sound wave technology can favour the enhancement of the plant immune system; thereby avoiding many environmental pollution issues and the financial expenses on chemical fertilizers and herbicides. Sound waves considerably enhance the division and development of callus cells ($P<0.05$), boost up protective enzyme activity and lipid fluidity (24). In addition, sound waves can also stimulate the secondary assembly of proteins; not only in the cell wall but also in the plasma lemma. However, the ideal stimulation of the sound frequency will alter, depending on the exposure time and application duration. Different plant types have different reactions to sound stimuli during various growth phases, as resonance occurs when the internal sound stimulation frequencies are in line with the spontaneous sound frequency of the plant (24).

Moreover, when the sound waves energy reaches the leaf, part of the sound energy vibrates the leaf and the other part of the sound wave energy reflects and diffracts around the leaf which affects the insects around the plants. Sound stimulates cause leaf stomata to open so that especially in the morning, plant can increase its absorption capacity of fertilizers and dew. The stimulation of noise is also very effective in bringing the herbicides into the plant. It is possible to spray mature weeds with 50% less herbicide and biocide. Sound stimulation therefore decreases the chemical fertilizer and pesticide requirements (15-25%). Improvement of the immune systems of crop, in addition to refining and reducing plant diseases, sound waves (SVs) may also stimulate endogenous hormones. Thus, acoustic frequency technology can support plant growth, increase output and yield value (25).

Sound waves can influence germination rates and increase plant growth and development, improving the yield of some crops (24). Moreover, it is also known that, sound waves can boost the plant immunity against pathogens and may also improvement their tolerance to drought. At the cellular level, sound vibrations can affect microfilament rearrangements, increase levels of soluble polyamines and sugars, modify the activity of various proteins and regulate the transcription of certain genes (23). The increases observed are greater in the plants exposed to musical sounds. The effects of the sound are complex and influential on the physiological mechanisms. Acoustic stress and environmental stress induce a down regulation of the expression of certain genes in particular (4).

Plants signalling under the influence of sound

Sound waves (SVs) increase the content of soluble proteins, transcription of genes and promote plant development. SVs can vary the secondary structure of plasma membrane proteins at the

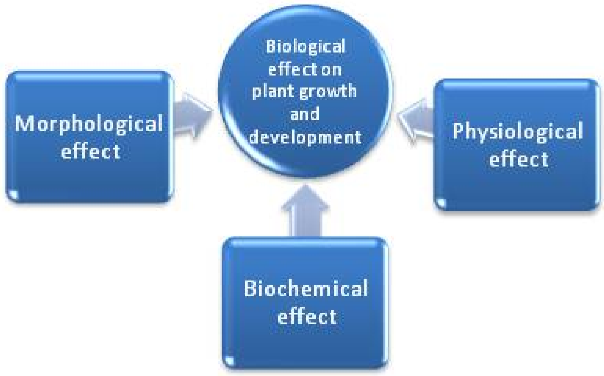


Fig. 1. Expression pattern of different types of morphological effects, physiological effects and biochemical effects on plants through music.

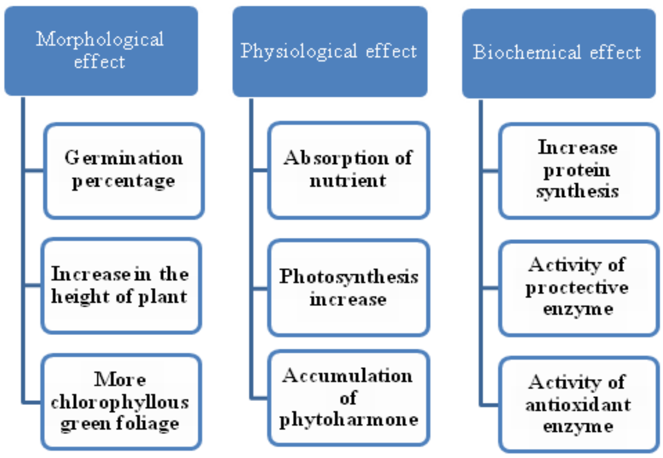


Fig. 2. Plant under the influence of music and shows different types of activities growth like growth, germination, Phytohormones, protein synthesis, oxidant and antioxidant activity, etc.

cellular level; mark rearrangements of micro filaments; generate signatures of Ca2-; provide increased protein kinases; protective enzymes, peroxidants, antioxidant enzymes, amylase, H+-ATPase/K+ channel activity and enhance polyamine, soluble sugar and auxin concentration (15). Sound wave used for *Chrysanthemum* plant can significantly alter the cell cycle and decrease the number of cells in stage G0 and G1 while in stage S it increased, indicating sound wave accelerated *Chrysanthemum* development (17). The cell proliferation method of the cell cycle demonstrates the characteristics of living activity in plants on the grounds of growth and development (15). CDKs are important cell cycle regulators and therefore their operations are fully controlled. Recent studies on CDK regulation and development, CDK inhibitors have been introduced. These full procedures have an effect on understanding the evolution of other signalling pathways to understand how the cell cycle can be connected machinery (15). Potential-based membrane mechanism or membrane-associated plant cell receptor(s) play an important part in perceiving SVs. In crops and animal cells, further advancement is estimated with the reality check of a mechanosensory network. Mechanical influence by SVs is like gravity, wind, tidal currents and rain (25). Growth improvement is the most frequently reported plant reaction to SVs stimulation. Phytohormones control plant growth reactions resulting from fast division elongation of cells (16) showed that by enhancing cell division, SVs can accelerate plant development (Fig. 3). This has been further validated by research that indicate alterations in phytohormone concentrations following SV stimulation, i.e. important increases in endogenous phytohormones such as gibberellin, indole-3-actic acid and cytokinin in crops such as cowpea, muskmelon, cucumber, tomato and eggplant (15).

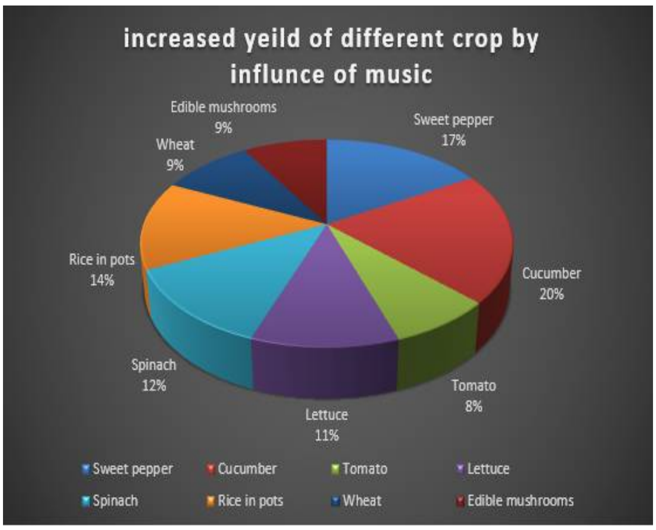


Fig. 3. Expression pattern of the Variance analysis results of increased yield activity of eight different crops influenced by music.

Importance of PAFT (Plant Acoustic Frequency Technology) in Biotechnology

Plant biotechnology, and in specific, plant tissue culture could profit from new ways of stimulating plant progress. Although there is a restricted amount of research, still there are proofs that sonication with small sound frequencies (as little as a few dozen Hz) can boost up organogenesis as high as ultrasound (numerous dozen kHz). There are several biological impacts of abiotic stress, i.e. low frequency ultrasound, with heat and chemical effects in the living organism. Cavitation and audible micro streaming altered cellular ultra-structure, enzyme stabilization and cell growth. In addition, it may interrupt extracellular polymers; release nucleic DNA; reduce cell stability; change the permeability of the cell membrane and change the cell surface charges. In the field of biotechnology and agriculture, SV treatments have positive effects in several growth parameters of plants. In plant tissue culture techniques, SVs have been initiated in favour of organogenesis (9**)**. In several crops, such as *Glycine max*, *Vigna unguiculata*, *Triticum aestivum* and *Zea mays,* ultrasound (sound above the 20–20000 Hz audible range) increased agrobacterium-mediated conversion. Further stimulation was also noted in the growth and development of different plant species such as *Daucus carota*, *Oryza sativa*, *Aloe arborescens*, *Gerbera jamesonii*, *Cucurbita pepo*, *Dendrobium officinale* and *Corylus avellane*. Cotton crops subjected to PAFT (plant acoustic frequency technology) showed enhanced height, leaf length, amount of bollard branches and bollards and individual bollard weight (15). While in strawberry crops increased photosynthetic characteristics and enhanced disease resistance was observed without influencing the yield (21). Treatment of rice crops with PAFT led in a rise in grain yield as well as quality: while yield improved by 5.7%, protein content in vegetables increased by 8.9%. Application of PAFT led to an increase of 17% in wheat yield along with an increase of 6.3.8.5 and 11.6% in starch, protein and fat content of the grain. The use of PAFT has improved the number of leaves and flowers, chlorophyll content and yield in crops including tomato, lettuce and spinach, while the spread of sheath blight in rice decreased by 50% (15). The post-harvest shelf-life of tomato fruits also improved under the impact of SV: treatment of tomato fruits with SVs of 1000 Hz delayed ripening, that controls 25 percent use of fertilizers can be decreased owing to the growing tendency of SVs to increase further immune responses to plant diseases and insect pests in crops (18). Collectively, the studies have demonstrated the possible big implementation of SVs to improve crop yield, defence, nutrient value, etc., which explains the detailed advantages of SVs therapy in biotechnology and agriculture (9). Sound waves can also control the

ISSN: 2348-1900

weed/other unwanted crop growth by electromagnetic energy, where sound waves pulsed to the right set of frequencies affected the plant at an energetic and sub molecular level (15).

The musical treatment in agriculture

Cell division, RNA content, development, sugar content, enzymes and hormones increased by 1000 Hz and 100 dB in callus cell or plant wound cells at 20 cm for 1 hr (17). The variable frequency generator of 60-2000 Hz and 50-120 dB at 50-100 meters improved plant immunity to pathogens, insects and pests. The frequency adjusted for 1-3 hours in the morning depending on temperature and humidity, improved the output of various plants like in wheat (17.0%), lettuce (19.6%), sweet pepper (30.05%), rice in pots (25.0%), cucumber (37.1%), tomato (13.9%), spinach (22.7%) and edible mushrooms (15.8%).

Conclusion and future aspect

Different environmental variables have significant impact on plant growth, development and genetic features. There is a strong link between sound waves and plant growth in many researches, since sound and sonication have a significant effect on plant growth and morphogenesis. It has been shown that sound waves with particular frequencies and intensities have important impacts on a multitude of biological, biochemical and physiological operations including plant gene expression. However, high frequency and intensity sound waves may be detrimental to adequate plant growth and development. In addition, these musical nodes can very useful in the fields of biochemistry, horticulture, physiology and ecology.

This collective data will open up new possibilities for further research to verify and clarify the connection between sound waves and plant reaction. This knowledge can be implemented to support yield in agriculture and this concept may also assist in the future to address the hunger issue throughout the world. Using sound waves for desirable crops might induce them to develop while inhibiting unwanted crops (e.g. weeds). For unambiguous knowledge, the mechanism of how sound impacts the cell cycle and plant growth requires further research and more scientific studies.

Acknowledgements

The authors are grateful to Prof. Aditya Shastri, Vice Chancellor, Banasthali Vidyapith for providing all necessary support. We acknowledge the Bioinformatics Center, Banasthali Vidyapith supported by DBT for providing computation support and DST for providing networking and equipment support through the FIST and CURIE programs at the Department of Bioscience and Biotechnology. CESME, Banasthali Vidyapith, supported by MHRD, Government of India under the PMMMNMTT is acknowledged for organizing the symposium.

Conflict of the interest

The authors declare that they have no conflicts of interest.

Author's contributions

Conceptualization by IS. Methodology, software, visualization and writing by PS. Review and editing by NJ. Supervision, investigation and original draft by NS.

References

1. Patel A, Sangeetha S, Seema N. Effect of Sound on the growth of plant: Plants pick up the vibrations. Asian Journal of Plant Science and Research. 2016;6: 6-9
2. Creath K, Schwartz GE. Measuring effects of music, noise, and healing energy using a seed germination bioassay. The Journal of Alternative & Complementary Medicine. 2004; 10(1):113-122
3. Kim JY, Lee JS, Kwon TR, Lee SI, Kim JA, Lee GM et al. Sound waves delay tomato fruit ripening by negatively regulating ethylene biosynthesis and signaling genes. Postharvest Biology and Technology. 2015;110: 43-50
4. Qi L, Teng G, Hou T, Zhu B, Liu X. Influence of sound wave stimulation on the growth of strawberry in sunlight greenhouse. In: International Conference on Computer and Computing Technologies in Agriculture. Springer, Berlin, Heidelberg. 2009:449-54
5. Aspinell L, Teng G, Hou T, Zhu B, Liu X. Influence of sound wave stimulation on the growth of strawberry in sunlight greenhouse. Computer and Computing Technologies in Agriculture III. 2010;317:449–54
6. Chrpova D, Kourimska L, Gordon MH, Hermanova V, Roubíčková I, Panek J. Antioxidant activity of selected phenols and herbs used in diets for medical conditions. Czech Journal of Food Sciences. 2010; 28(4):317-25
7. Hou T, Li B, Wang M, Huang W, Teng G, Zhou Q et al. Influence of acoustic frequency technology on cotton production. Transactions of the Chinese Society of Agricultural Engineering. 2010;26(6):170-74
8. Zhang J. Application progress of plant audio control technology in modern agriculture. Ningxia Journal of Agriculture and Forestry Science and Technology. 2012;53:80-81
9. Wang X J, Wang BC, Jia Y, Duan CR, Sakanishi A. Effect of sound wave on the synthesis of nucleic acid and protein in Chrysanthemum. Colloids and Surfaces (B: Biointerfaces). 2003;29:99-102
10. Ehlers JD, Hall AE. Cowpea (*Vigna unguiculata* L. Walp.). Field crops research.1997;53(1-3):187-204
11. Kim JY, Lee JS, Kwon TR, Lee SI, Kim JA, Lee GM et al. Sound waves delay tomato fruit ripening by negatively regulating ethylene biosynthesis and signaling genes. Postharvest Biology and Technology. 2015;110:43-50
12. Dassonneville L, Lansiaux A, Wattelet A, Wattez N, Mahieu C, Van Miert S et al. Cytotoxicity and cell cycle effects of the plant alkaloids cryptolepine and neocryptolepine: relation to drug-induced apoptosis. European Journal of Pharmacology. 2000;409(1):9-18

13. Alavijeh RZ, Sadeghipour O, Riahi H, Dinparvar SV. The effect of sound and music on some physiological and biochemical traits, leaf nutrient concentration and grain yield of cowpea. IIOAB Journal. 2016;7:447-58

14. Wang XJ, Wang BC, Jia Y, Huo D, Duan CR. Effect of sound stimulation on cell cycle of *Chrysanthemum* (*Gerbera jamesonii*). Colloids and Surfaces (B: Biointerfaces). 2003;29:103-07

15. Yang X, Wang B, Ye M. Effects of different sound intensities on root development of *Actinidia chinensis* plantlet. Chinese Journal of Applied and Environmental Biology. 2004;10(3):274-76

16. Exbrayat JM, Brun C. Some effects of sound and music on organisms and cells: A review. Annual Research & Review in Biology. 2019;1-12

17. Klein RM, Edsall PC. On the reported effects of sound on the growth of plants. Bioscience. 1965;15(2):125-26

18. Mishra RC, Ghosh R, Bae H. Plant acoustics: in the search of a sound mechanism for sound signaling in plants. Journal of Experimental Botany. 2016;67(15):4483-94

19. Lees E. Cyclin dependent kinase regulation. Current Opinion in Cell Biology. 1995;7(6):773-80

20. Arts IC, van de Putte B, Hollman PC. Catechin contents of foods commonly consumed in The Netherlands. 1. Fruits, vegetables, staple foods, and processed foods. Journal of Agricultural and Food Chemistry. 2000;48(5):1746-51

21. Bose JC. Response in the Living and Non-living. Longmans, Green, and Co. 1902

22. Gagliano M, Mancuso S, Robert D. Towards understanding plant bioacoustics. Trends in Plant Science. 2012;17(6):323-25

23. El-Rahman FA. Insight into the effect of types of sound on growth, oil and leaf pigments of *Salvia officinalis* L. plants. Life Science Journal. 2017;14(4):9-15

24. Meng Q, Zhou Q, Zheng S, Gao Y. Responses on photosynthesis and variable chlorophyll fluorescence of *Fragaria ananassa* under sound wave. Energy Procedia. 2012;16:346-52

25. Lawless J. The Encyclopedia of Essential Oils. Element Book Ltd. Long Mead, Shoftesbury. Dorest. Great Britain. 1992