

# Ancient Indian Traditional and Scientific Thought on Plants: Sir JC Bose and Vrikshayurveda

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## Abstract

*The 150<sup>th</sup> birth anniversary of one of the greatest physicists of India, Sir JC Bose was celebrated in 2008. His paper “On the similarity of effect of electric stimulus on inorganic and living substances” presented in 1900 in Paris, France remains a classic today. Bose’s studies reflected Vedic thoughts. In this paper, we have made an effort to highlight those thoughts expressed in ancient Vedic literature, which have a bearing on Bose’s studies.*

The 150<sup>th</sup> birth anniversary of Sir Jagadish Chandra Bose (1858–1937), the pioneer of modern science and scientific experiments in India was celebrated in 2008. A physicist by training, profession, and research, his work in the property and application of electro-magnetic waves earned him a place in the list of renowned world physicists. He was however, a biophysicist by choice and in his research he turned more and more to plants applying his proficiency in physics to investigate into their inner core. He became a world celebrity not so much for his research work in physics as for his pioneering research in biophysics.

most important paper titled “On the similarity of effect of electric stimulus on inorganic and living substances”, which Sir Bose presented in 1900 at the International Congress of Physics held in Paris, France. Outstanding inventions far ahead of their time do stand in need of original means and instruments, too. For composing his world-famous Ashtadhyayi, Panini, the famous grammarian of Sanskrit, invented his own technique. For his investigation in the

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The year 2008 was also significant for India as it marked the 108<sup>th</sup> anniversary of the

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responses of the inorganic and living matter to various stimuli, Acharya Bose, too, devised his instrument '*crescograph*', which in measuring accuracy was decades ahead of his time. He compared the response of metals, plants, and animals to electrical, chemical, and mechanical stimulations, and documented them in his famous book "Response in the Living and Non-Living", published in 1902. The outcome of his investigations and research experiments related to plants can be summed up in a non-technical language in the following statements:

1. The growth-rate, and the actual moment of death of a plant could be measured and recorded accurately (with the help of the *crescograph*).
2. Responses of the plants to stimulations of heat, light, gravity, and electricity, too can be measured and recorded accurately.
3. As a result of the accuracy it is possible to compare these responses with those of the nonliving matters like metals and so on.
4. It is obvious from statement nos. 1, 2, and 3 that in the experiments, plants represent 'living matters' while metals represent 'the nonliving'.
5. That plants are living matters is, therefore, already an established and

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accepted fact for Acharya Bose. The thought could be absorbed from tradition and culture as it naturally percolated through ancient Sanskrit literature.

6. As living matters, plants respond to stimuli as if they have nervous systems like animals.
7. After studying the effect of microwaves, chemicals, and temperatures on the plant tissues and the corresponding changes in their cell membranes, Acharya Bose proved that plants can 'feel pain and understand affection and other feelings'. According to him a plant treated with care and affection gives out a different vibration compared to a plant subjected to torture.
8. Acharya Bose also proved that plants had finer senses like responding to melodious music and harsh noise. He showed that with the former the plants grow faster while with the latter their growth is stunted.

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9. Acharya Bose not only gives a strong scientific basis for the traditionally known and accepted fact of plants having life but also takes the knowledge further with his scientific acumen to its logical corollaries.
10. Gradually through advanced experiments he also proved that even the nonliving matters like metals and stones respond to stimuli (though very inertly) in a way similar to the muscular responses of the living.
11. Acharya's research starting with the investigation of the plants, applying his expertise in Physics to them, thus systematically and naturally culminates in proving the age-old humanist faith in the basic unity of all life which ancient Vedantins like Shankaracharya promulgated through their treatises as the doctrine of 'A-dvaita' meaning 'nonduality'. They believe that the ever existent (*sat*), ever sentient (*cit*), and all pervasive (*sarvavyapi*) Brahman alone is the root cause of the universe, both living and nonliving.

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A British editor once said about JC Bose, "In Sir Jagadish the culture of 30 centuries has blossomed into a scientific brain of an order which we cannot duplicate in the West." Comparing and combining this remark with statement nos. 5, 9, 10, and 11, it is worthwhile to take a fresh survey of the knowledge base provided through the centuries by our tradition, culture, and ancient literature in respect of plants and plant-responses.

- In Vedic literature (8000–1000 BC), especially in the Atharvaveda (c. 1000 BC), plants are treated as deities. Independent Suktas to *Vanaspathis* like *Ashvattha* (III 6), *Laksha* (V 4), and so on are addressed to them superimposing many qualities of living beings on them. Most of these Suktas invoke these 'deities' to cure diseases.
- In Yaska's *Nirukta* (A treatise on etymology of Vedic words), 'being' (life) is stated to have six modifications (*shad bhaavavikaaraah*) which are: *jayate*, *asti*, *viparinamate*, *vardhate*, *apakshiyate*, and *mriyate* (birth, existence, change, growth, decay, and death). Since plants are born, they exist, change, grow, decay, and die as they are 'beings'.

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Birth and existence of plants are axiomatic facts for Acharya Bose. Change, growth, decay, and death in plants are scientifically proved by him with the help of the *crescograph* (vide statement nos. 1 and 2).

- Smritis of Manu (c. 200 BC) and others as also Ayurveda (cf Sushrita 400 BC Su.1) describe four categories of living beings: *jarayuja*, *andaja*, *swedaja*, and *udbhijja*; i.e., those born from womb, from egg, from sweat, and from ground. The last mentioned category denotes plants which are 'born' by breaking open the crust of the earth.

That plants are 'born' and are living beings is the very foundation of Acharya's research, too (vide statement nos. 4 and 5).

- Almost all ancient texts relevant to the topic broadly classify living beings in two categories: *Sthavara* and *Jangama* (Static and Moving) and trees belong to the first category. Plants are thus treated on par with the living beings. Specific reference can be seen in Mahabharata (c. 3000 BC) (Shanti. 184-5).

In his research experiments if Acharya Bose preferred plants (*sthavara*) to other animals (*jangama*), it is only for the sake of convenience. Handling stable plants was always easier and more convenient than handling the moving animals.

- In Mahabharata (Shanti. 184), there is a passage wherein Bharadwaja asks sage Bhrigu a pointed question 'whether or not trees have life' and the sage asserts that the trees do have life and that there is no question of regarding them lifeless (*jivam pashyaami vrikshaanaam achaitanyam na vidyate* – V. 17). Such statements from sages like Bhrigu are like scriptural dictums in Indian culture and tradition which believe in 'aptavakya' (word of unquestionable authority) as a valid 'pramana' (means of acquiring knowledge).
- In Ayurveda, Charaka (700 BC) defines 'living organism' as one that has body, sense organs, mind, and soul (*sharirendriyasattvatmasamyogadhari jivitam*). That plants have body is self-evident.

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- That they have sense organs, too, is explained with reasons in the Mahabharata (Shanti.) passage:
    - Creeper entwines her coil round the tree 'finding' its path all over. The blind cannot find their path. Therefore, plants can see (184-13).
    - After a harsh sound of stormy wind, fire, or thunder, the flowers and leaves of trees fall off apparently out of scare. Obviously they can hear and react to sound (184-12).
- Acharya proved it scientifically (vide statement no. 8).
- Trees react to good and bad smell and through fumigation by various materials can be cured of their diseases. Hence they can smell (184-14).
  - Leaves, flowers, fruits, and bark of trees dry up and fall down with heat. It is the sense of 'touch' that reacts to heat and cold. So trees can feel touch.
  - Trees 'drink' water with their roots ('padapa' a tree, is so called because it consumes its nourishment with 'feet' – *padaih pibati*). They are subject to diseases and can be treated (by mixing

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remedial materials in the water that they consume). Responding to such treatment is a proof of their having the sense of taste (184-15).

Many of Acharya's experiments on plants have scientifically proved the above stated facts.

- Trees can feel happiness and sorrow (184-17), which is a function of mind. Therefore, they have mind.

Acharya proved this from the analysis of the nature of variation of the cell membrane of plants, under different circumstances (vide statement no. 7). The above mentioned sense organs and mind cannot function without a sentient substratum. Hence trees must have soul, too.

It must be noted incidentally that Mahabharata is stated to have been the source of inspiration for Acharya's experiments on plants. So far we have discussed Acharya's experiments on various aspects of plants and their probable connection with our tradition and culture, passed on to us through ancient Sanskrit literature.

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## Vrikshayurveda

In the following sections the same will be discussed with special reference to “Vrikshayurveda”, an ancient science of that name and the 10<sup>th</sup> century treatise of that title on the subject ascribed to Surapala. Although Acharya’s research work comes a full millennium after Surapala’s Vrikshayurveda, the latter being the first available full-fledged text on the science of arbori-horticulture, its approach to and treatment of plants in many respects are of direct connection with the plant experiments of Acharya Bose. It becomes, therefore, necessary to know in more detail about what this science and Surapala’s text are about.

There is ample documentary evidence to show that such a branch of learning existed in ancient India. There are frequent references to this science in ancient Indian literature such as Atharvaveda (c. 1000 BC), Arthashastra of Chanakya (321–296 BC), Brhatsamhita of Varahamihira (6<sup>th</sup> century AD), and Sarngadharapaddhati of Sarngadhara (13<sup>th</sup> century AD).

Until recently only the name of the author and that of the text were known as they were preserved by tradition. In 1994, the Asian Agri-History-Foundation in Secunderabad, India succeeded in procuring this rare manuscript from the Bodleian Library of the Oxford University, London, UK in course of its research activity devoted to unearthing documentary evidence to bring to light the contribution of South and Southeast Asia to the field of world agriculture and allied subjects. It was written in the Devanagari script of a much earlier

stage. It was printed and published in 1996 by the Foundation as its first research bulletin along with original script, its English translation (Sadhale, 1996) and scholarly commentaries of noted agricultural scientists of the present day, bringing to light India’s rich heritage in the field of horticulture.

## Contents

Vrikshayurveda, mainly deals with various species of trees and their healthy growth and productivity. The text mentions about 170 species of plants, including herbs, shrubs, and trees. There are 325 systematically arranged verses, beginning with a salutation to Lord Ganesha, followed by glorification of trees, and composition on tree planting and production. Various chapters deal with the raising of orchards, agri-horticulture, and tree planting near houses. Special references are made to procuring, preserving, and treatment of seeds and planting materials; preparation of pits for planting; selection of land (soil); methods of irrigation and ways to locate groundwater; nourishment and fertilizers; diseases of plants and plant protection; laying out of gardens and orchards; creation of

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agricultural/horticultural wonders; use of plant species as indicators of crop and animal production; and description of sacred plants.

## Plant protection

Plant protection was already recognized as an important activity. Details of the symptoms of various disorders must have been observed over long periods before arriving at definite descriptions and attributing specific symptoms to various causes. We are not aware of any other attempt in the world by which plant disorders were classified into two groups; i.e., internal and external, before the time of Surapala. Further it is very significant that physiology of trees was considered similar to those of humans and the internal disorders of trees were attributed to *vata*, *kapha*, and *pitta* kinds as had been done in case of humans. Several of the symptoms described can be attributed today to fungi, bacteria, viruses, or nematodes (Nene, 1996). In addition damage due to other non-infectious causes (external) such as excessive heat, frost, mechanical injuries, drought or waterlogging, birds, excessive growth of (parasite?) creepers, and competition by weeds was recognized.

Considerable thought must have been given over centuries to the remedies before prescriptions to manage the disorders could have been formulated. It is most significant that various methods of treatments, adopted today, were conceptualized and practiced centuries ago. Seed treatments, prior to sowing, to ensure successful and vigorous germination were given a lot of importance. Good nutrition was recognized as a

preventive measure for ailments and at the same time wrong treatments and excessive application of remedial materials were recognized as problem-creating situations. Dressing of wounds, mechanical or physiological, was in vogue. Application of pastes over affected tree surfaces was suggested. Drenching of soil with various materials was a recommended practice. Treating roots before transplanting was recommended. Fumigation of trees and seeds by burning (to produce smoke) specific materials was considered to be useful. Spraying/dusting with appliances, as we do today, had not evolved, but the crude versions of these are found in sprinkling aqueous suspensions of materials and application of brick-powder as dust.

Several botanicals (herbs) and other materials had been identified and recommended for application on ailing plants. We know today that many of the herbs recommended by Surapala possess biocidal properties. Modern humans will raise eyebrows when they would think of applying milk to trees, but we must remember that almost every farmer, as in remote villages of India even today, kept cows and/or buffaloes. If there was no market for these products nearby, the farmer must have

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had more milk than the family needed. Such a surplus could have easily been spared for trees. Today, scientists are rediscovering the efficacy of milk in controlling plant disorders.

## Vrikshayurveda in contemporary times

In today's world, global environmental issues relating to sustainable development have emerged as topics of major concern. The Bruntland Commission report of 1976 and the Agenda 21 adopted by the United Nations Conference on Environment and Development have challenged us to look beyond the obvious issues of producing more food together with giving a fuller recognition to issues of biodiversity. Vrikshayurveda is replete with references that suggest that raising trees is a means of attaining the four broad aims of life: *dharma*, *artha*, *kama*, and *moksha*, which broadly mean that for a holistic development of mankind and its welfare in all its spheres including inter-generational equity, trees have an important place. These are key words for today's sustainable development of agriculture.

## Ecology and Vrikshayurveda

The place of horticulture in ecology both at the home garden scale and at the field scale was well understood, as is evident from references such as in Verse 9: "A person is honored in Heaven for as many thousand years as the days he resides in a house where *tulasi* (sacred basil) is grown"; or in Verse 10: "And if one properly grows *bilva* (bael), which pleases Lord Siva, in his family (courtyard), the goddess of riches resides

permanently (in his house) and this (riches) is passed on to his sons and grandsons." Apparently the place of trees in environmental maintenance and food chain was well understood. The saints and philosophers of the time extolled the people to 'grow more trees' – a slogan that we seem to have rediscovered during the past few decades.

## Where was Surapala located?

From the types of soils, plant species, and kinds of plant protection materials, we believe that Surapala was referring to the Bihar-Orissa region.

The brief information above should be sufficient to establish the rare place of importance the work occupies in the ancient Indian scientific thought in the field of Arbori-Horticulture.

## Vrikshayurveda and Acharya's discoveries

Besides theory and practice of horticulture, as explained above, Vrikshayurveda contains many incidentally referred facts about plants which can be discussed in the context of plant-discoveries by Acharya Bose.

- Vrikshayurveda accepts the fact of plants having life as an axiomatic truth right from the title that contains the word 'Ayur' meaning life as does Acharya Bose for his experiments. (Perhaps both inherit the thought from the tradition as seen above.)



- Surapala advises people to treat plants like human beings, as an important part of their life as would be evident from several verses: The value of a tree is equal to ten sons (*dashaputrasamo drumah*) (see Verse 6). In usefulness to others, trees are far better than irresponsible sons of the family as they at least offer the much needed shade to the passers by (see Verse 4). Trees dutifully offer flowers and fruits (as though libations) to their deceased father (planter) while disrespectful sons fail to do even that (see Verse 5).
  - Trees are the great benefactors of human beings. They save families from utter poverty (by offering them livelihood) (see Verse 97).
  - Trees are the means of realizing the fourfold fundamental aspirations of human life; viz., *dharma*, *artha*, *kama*, and *moksha*. Hence one must plant trees (*vriksharopam samarabhet*) (see Verse 98).
  - Planting of certain trees like *tulasi*, *bilva*, and *ashvattha* (pipal) is specifically recommended for welfare here and hereafter (see Verses 9 to 23). Such advice to common man naturally would inculcate in his mind, reverence for trees.
  - Planting a tree is described as a happy and solemn occasion to be celebrated after ascertaining an auspicious day and time (see Verses 61 and 62). The suggestion here is that plants are like members of the family and deserve similar attention.
  - If there is need to transplant a big tree, the planter is advised to recite a *mantra* the previous evening to avoid sudden shock. The content of the *mantra* is intended to reassure the tree of affection and care in the new place (see Verses 84–86).  
  
Acharya proved scientifically that plants respond to stimuli as if they have nervous system like animals (*vide statement no. 6*).
  - A special care in the nourishment of newly planted trees advised in Vrikshayurveda (see Verses 107–109) also reveals the same concern and tender affection for plants. Surapala advises planters to take maximum precaution to protect the tree from frost, stormy wind, fire, smoke, and pests like spiders.  
  
This tender care and affection for the plants leading to good results is later validated by Acharya's experiments on plant stimuli (*vide statement no. 7*).
  - Weeds around the trees at the root must be uprooted but Surapala does not forget to add that this work must be done by a knowledgeable person to avoid injury to roots of the tree (see Verse 115).  
  
Various special nourishments are recommended in Vrikshayurveda for young and old trees for their healthy growth which helps them grow strong and combat diseases if and when necessary.
- In the chapters on ailments and treatment there is a warning that tender plants must

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not be subjected to fumigation by powerful materials (see Verse 221).

In the chapter on horticultural wonders, for obtaining dwarf varieties of trees it is necessary to slit open and burn the portion of the trunk slightly. Surapala forbids planters from using these aggressive methods on tender trees (see Verses 262 and 263).

These above-stated directions in the text conceptualize the discovery of Acharya Bose regarding plants responding favorably to affection and care (vide statement no. 7).

- Verses 147 to 150 refer to some curious practices for healthy and quick growth of trees which include sprinkling the tree with a mouthful of wine, etching with nail on the trunk, giving a gentle kick with the foot decorated with jingling anklet, embracing with hands adorned with trinkets gently ringing pleasant sound – all of course by beautiful ladies. There are frequent references to such practices in Sanskrit poetry, too. In Kalidasa's play *Malavikagnimitram*, it is depicted that it was a prestige issue for ladies of the royal family as to which one of the queens or beloveds of the king gets the honor of

kicking the tree ceremoniously. However, for Sanskrit scholars such references were just poetic conventions or rhetorical descriptions.

It was for Acharya Bose to prove them as scientifically valid practices. That plants respond favorably to melodious music was validated by his experiments on plant responses (vide statement no. 8).

- A *shyama* creeper is stated to blossom in response to a wedding-like ceremony with a nearby tree (see Verse 151). Kalidasa's *Shakuntala*, too, describes it. Even this is regarded as convention or rhetorics.

If plants are proved to have finer senses like appreciation of beauty and melodious music, they may even have finer feelings. That they respond to happiness and sorrow is already established by Acharya Bose (vide statement no. 7).

- The most noteworthy fact in *Vrikshayurveda*, however, is that it applies the *tridhatu* theory of *Ayurveda* (the science of life) to plants. *Kapha*, *pitta*, and *vata* are treated as the basic components of plants, too, as of humans and the theory that a balance of the three indicates health and imbalance caused due to vitiation of any one or more of them indicates disease is extended to plants too, justifying its title 'Vrikshayurveda'. Even the treatment material prescribed in many cases is the same or similar to that of humans. Surapala, generally considers plants as equal and in some respects even superior

to humans as stated above. But in this respect he treats them specifically equal to humans. He has asserted that in physiology, pathology, and pharmacology too, plants can be treated on par with humans.

Acharya Bose's discoveries on plants brought them even closer by revealing the truth about their nervous system.

Such was the knowledge-base handed down by tradition in respect of plants. Constant observation, practice, and experience too, must have played a major role in it. As per ancient Indian *shastras* there are four means of acquiring valid knowledge: (i) word of unquestionable authority (*shabda*); (ii) perception (*pratyaksha*); (iii) inference (*anumana*); and (iv) analogy (*upamana*). The facts about plants as known to tradition were based on *shabda*, *anumana*, and *upamana*. Acharya proved them by methods of modern science as were acceptable to the modern academic world and added the fourth dimension *pratyaksha*, i.e., perception to them.

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