Leaves whisper their properties through ultrasound

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Leaves whisper their properties through ultrasound. Credit: Pranav Yaddanapudi

The water content of leaves, their thickness, their density and other properties can now be determined without even having to touch them. A team of researchers from the CSIC Institute of Acoustics and the Agri-Food Research and Technology Centre (CITA) of Aragón has just presented an innovative technique that enables plant leaves to be studied using ultrasound in a quick, simple and non-invasive fashion.

Tomas E. Gómez, one of the authors of the study and researcher at the CSIC Institute of Acoustics, where a technique has been developed to analyse these parts of plants without touching them, explains to SINC that "The method involves establishing a silent dialogue with plant leaves, questioning them and listening to what they say".

The research, recently published in the journal, *Applied Physics Letters*, demonstrates that some properties of leaves such as thickness, density or compressibility can be determined with this method.

"The voice of the leaves itself is what gives us information about their status and their properties, all in an innocuous and silent way since communication is established by ultrasound, with above-audible frequencies", the scientist indicates.

The technique involves radiating the leaves with broadband ultrasonic pulses (between 0.2 and 2 megahertz), which are emitted through the air from portable devices. In doing so, the leaves start to vibrate and an ultrasonic sensor very similar to the transmitter detects the waves. The signal is then digitalised and the researchers analyse the resonance range, which enables the characteristics of the leaves to be assessed.

The entire process is done in a way that is non-intrusive to the plant. Until now, coupling fluids have been used between the ultrasound transmitter and the material being studied, as is in the case in medicine, for example, when gels or oils are applied to perform an ultrasound.

Listening to leaf moisture

Eustaquio Gil-Pelegrín, co-author of the study and researcher at the Forestry Resources Unit of the Agri-Food Research and Technology Centre (CITA) in Aragón, which has also taken part in the research, explains to SINC that "With this method we can also directly estimate, without contact or interference, the water potential of leaves very accurately".

Information about water content enables us to analyse the loss of turgor in the leaves and the internal morphology of their cell layers, which in turn makes it possible to assess the level of development and to see how

they are influenced by environmental factors. Research on the status and water potential of plants helps to diagnose the situation of agricultural and natural systems.

Gil-Pelegrin emphasises the effectiveness of the technique, "even to detect critical moments for plants, such as stomatal closure". Gas and liquid exchange takes places through these pores on the surface of the leaf, and [stomata] opening is determined by factors such as light, CO_2 concentration and water availability. For example, when there is a drought the stomata close.

Scientists have successfully applied the ultrasound method to the study of perennial leaves (Prunus laurocerasus and Ligustrum lucidum) and deciduous leaves (Populus x euroamericana and Platanus x hispanica).

The team also took cuttings of some leaves to ascertain water loss over time, and they observed variations in leaf resonance and even water mass loss as little as 1%. The details of this line of research will soon be published in the Journal of Experimental Botany.

More information: T. E. Gómez Álvarez-Arenas, D. Sancho-Knapik, J. J. Peguero-Pina y E. Gil-Pelegrín. "Noncontact and noninvasive study of plant leaves using air-coupled ultrasounds". *Applied Physics Letters* 95 (19): 193702-1, 2009.

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