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**XVII Spanish-Portuguese Symposium
on Plant Water Relations**

*Water relations in plants to address current
challenges for plants*

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Spatially localized non-contact resonant ultrasonic spectroscopy in plant leaves using focused beams

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Abstract:

Plant-based sensing is increasingly recognized as a valuable approach for irrigation management, as plants inherently integrate information from soil water availability, atmospheric conditions, and their own physiological status. Within this framework, a focusing method that preserves the frequency bandwidth of air coupled ultrasonic transducers was used for the analysis of thickness resonances in plant leaves. The primary objective was to reduce the cross section of the ultrasonic beam, enabling the use of non-contact resonant ultrasonic spectroscopy in species with leaves that are too small or morphologically irregular to be examined with non-focused beams, and the study of spatial heterogeneity or local gradients across the leaf surface. Our experimental results demonstrated that the technique maintains the original frequency bandwidth while decreasing the beam diameter from the typical 20–25 mm of non-focused transducers to less than 3 mm when flat transducers combined with off axis parabolic mirrors are used. Validation was performed by comparing measurements obtained with focused and non-focused beams in leaves of different species suitable for both approaches. The method was subsequently applied to characterize spatial variability in thickness resonances associated with anatomical heterogeneity within individual leaves. Finally, changes in the resonance spectra during progressive



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dehydration were monitored in *Ligustrum lucidum* and *Olea europaea* leaves—the former serving as a reference due to previous studies, and the latter illustrating the applicability of the technique to leaves incompatible with non-focused beams.

Keywords: Irrigation, Dehydration, Thickness resonances, New Technologies, Air-coupled transducers, Plant sensing.

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