Water Stress Effects on the Changes in Chemical Composition in Leaves of Bean. A Fourier Transform Infrared Spectroscopy Study

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Introduction. Water stress is one of the most important abiotic stress factors limiting plant growth and productivity. Common bean (*phaseolus vulgaris* L.) is a major source of protein in the developing countries, but plant growth and yield are often reduced by periods of water stress.
This work explores the ATR spectral variation in leaves under water stress; the experimental protocol was developed to detect the corresponding changes in chemical composition of a bean plant to suffer water stress.

Methods. Plants analyzed correspond to the variety Azufrado Higuera in the vegetative phase during the germination stage. Spectra were obtained by 120 scans for each sample with a 4 cm^{-1} resolution. The obtained IR spectra were further processed by deconvolution and curve fitting to examine the chemical nature of the leaves responding to the stress source.

Results. The spectra results in the region between 1000 and 2000 cm^{-1} are show in figure 1. We observe the absorption bands around 1745 cm^{-1} correspond to isolated carbonyl group (COOR), indicating ester containing compounds commonly found in membrane lipid and cell wall pectin. The amide I region, absorbing near 1625 cm^{-1}, arises mainly from C=O stretching vibration with minor contribution from the out-of-face CN stretching vibration, the CCN deformation and the NH in-plane bending, the amide II (~1550 cm^{-1}) region is the out-of-face combination of the NH in plane bending and the CN stretching vibration with smaller contributions from the CO in plane bending and the CC and NC stretching vibration. The amide III (1400-1200 cm^{-1}) region is the in-face combination of the NH bending and the CN stretching vibration with small contributions from the CO in plane bending and the CC stretching vibration.

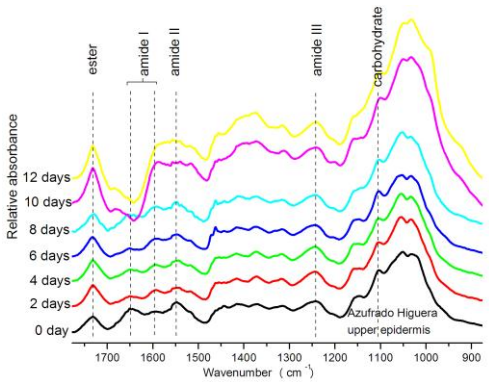

Fig.1 The effect of water stress on the FT-IR absorption spectra of 12-days bean plants stressed.

Bands around 1100 cm^{-1} in the "fingerprint" region indicate several modes such as C-H bending or C-C stretching. Carbohydrates in the leaves were the mayor constituents that contributed to these absorption bands. The area of two relative isolated bands, around 1745 cm^{-1} (ester) and 1100 cm^{-1} (fingerprint) bands, were integrated and plotted against time of stress (Fig. 2). In bean plant, an increase in the 1730 cm^{-1} band intensity was observed after 2 d of stress. This result suggests that the accumulation of cell wall pectin, as indicated by the increase in the ester band area, continued en bean plant, the accumulation of carbohydrates continued in the plants after 8 d of water stress, as indicated by the increase in the 1100 cm^{-1} band area.

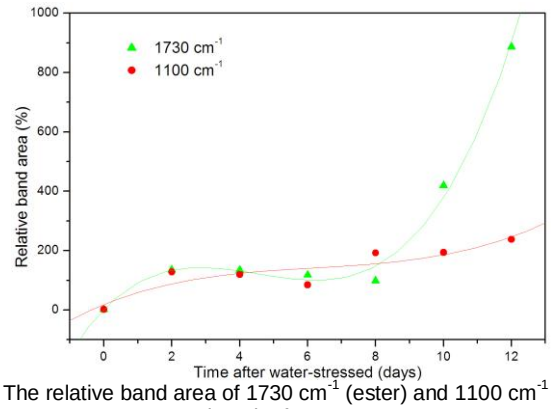

Fig.2 The relative band area of 1730 cm^{-1} (ester) and 1100 cm^{-1} versus length of stress.

Conclusions. FT-IR is able to detect the chemical changes at early stages of water stress. Using this technique we can monitor variations in the chemical composition into foliage of a bean plant to be subjected to stress.

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