Application of Magnetic Resonance Imaging (MRI) in plant-water relationship

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Water plays an essential role in plant development. According to the last IPCC Report and regional climate modeling results possible change is expected for the Carpathian-basin in its quantity and distribution too. Several abiotic stress factors have negative effects on plant-water relationship therefore in purpose of suitable development of the plants it has high importance to investigate this relationship in wide details.

MRI measurements used in human diagnostics gives a novel tool to the researchers of plant physiology to examine the plant-water relationship. MRI makes the examinations on the spin-system; therefore it can realize very accurate measurements. The spins only have weak interactions with macroscopic parameters of the biological system under test that will affect its behavior from biological and chemical aspects. This non-destructive method allows to measure one plant several times shifted in time.

The aim of our research is to expand the adaptability of MRI measurements used in human diagnostics for examination of water barriers in living plants. Cucumber (Cucumis sativus) and Phyllirea angustifolia were chosen as test plants. The measurements were carried out at Kaposvár University Institute of Diagnostic Imaging and Radiation Oncology by Siemens Avanto type MRI equipment. Two different relaxation times were applied: T_1 that is capable of histological mapping, and T_2 which is used for examining water content. MRI measurements were made using 3-3 sample plants in the same position. In the analysis, proof was found that certain histological formation and branching cause modification in the intensity detected in T_2 relaxation time and these positions can be detected in T_1 measurements. Linear correlation can be experienced between T_1 and T_2 measurements. Linear correlation coefficient was 0.8223 in case of cucumber and 0.8874 for Phyllirea angustifolia, respectively. During the statistical analyses of the signal intensities of xylem it can be concluded that they are not independent in statistical sense. The course of the intensity in xylem elements depends on the anatomic structure. Intensity profile is modified by nodes, by leaves and branches.

Measurements of very high resolution can be made by MRI equipment. This tool can claim high importance in the future during tracing processes of the plants and analyzing the effects of abiotic stresses (e.g. heavy metal stress, freezing).

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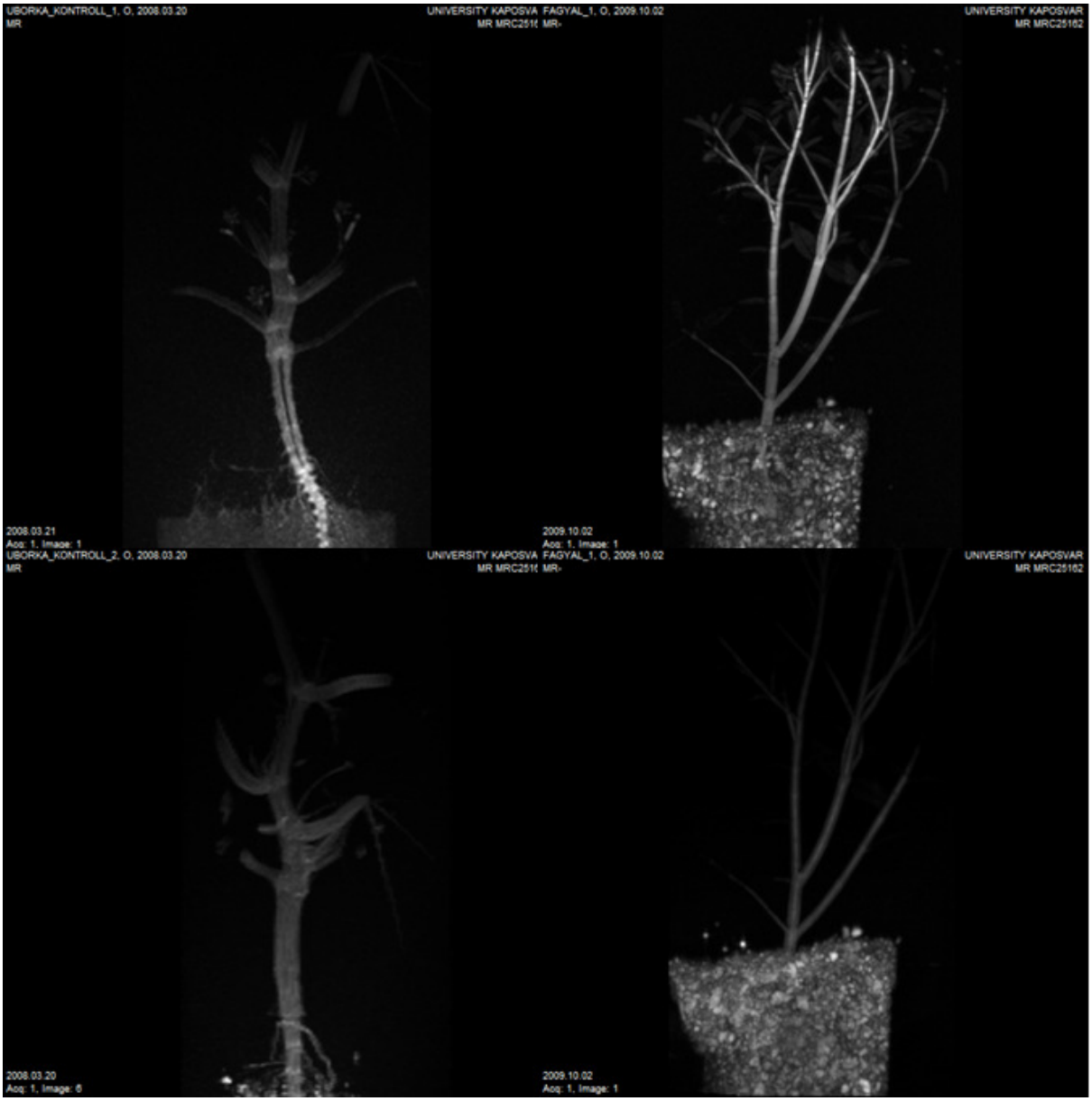

MRI pictures of the plants used in MRI measurements (above are the T_1 measurements and below are the T_2 measurements of cucumber and Phyllirea angustifolia from the left to right side, respectively)