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A new Lysimeter-based platform and analysis to monitor the soil-plant-atmosphere dynamic processes under varying levels of soil water availability

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A major purpose of lysimeters use is to study the soil-plant system response to a gradual development of soil-water shortage in general, and plants response to a developing drought and recovery at its end when delayed rainfall event or irrigation take place. Such knowledge becomes substantially essential under rainfall temporal irregularities that is associated with the global climate change. Plants in the soil-plant-atmosphere continuum (SPAC) are subjected to simultaneous atmospheric water demand and soil water flux into their roots that should compensate for the demand. As long as the soil hydraulic conductivity does not limit the current transpiration rate, the latter is controlled by the atmospheric demand. However, when soil water diminishes, soil hydraulic conductivity gradually becomes the limiting factor causing the plants to reduce transpiration by closing the stomata with all the associated effects that it has on plant development and crop yield. Two major questions then arise: 1) at which soil water content the above-mentioned switch in water availability takes place, and 2) how do different plants adjust themselves to the second phase?
A newly developed high throughput lysimeters system will be presented. The system monitors simultaneously for a large number of plants the variation in plant weight, soil water content in the rhizosphere, and atmospheric demand at high-frequency. The measured data are analyzed to provide the momentary transpiration rate water flux to the roots, and the effect of the balance between these fluxes on the plant physiological traits under normal conditions and gradual decrease in soil water content. The replacement of the commonly used description of transpiration rate vs. time by the transpiration rate vs. soil-water content, which yields a piecewise linear curve, enables to provide answers the two above-mentioned questions. The break point between the two linear lines designates the soil water content that becomes a limiting factor under the given environmental conditions. Moreover, the break point being for the different plants/cultivars, together with the continuously measured transpiration rate, enable to evaluate the plants drought resistivity and resilience. The application of these results to plant phenotyping, screening, water use efficiency characterization, and soil water management (e.g. irrigation) will be further discussed.