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Development of a method to describe irrigation effect on root growth and architecture based on CT-scan images.

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The root system and its architecture play an essential role in the plants physiology, from stability for aboveground structure to water and nutrient transport and storage. However, due to the opaque characteristic of the soil or other growing media and the fragility of some of the root system structure, non-destructive temporal observation remains difficult. Furthermore, the 3D model construction of plant and root system is also a challenge. The ability of the computed tomography technology to recover a correct representation of the 3D shape and architecture of a root system is promising and could allow an accurate phenotypic description and information gathering with a non-destructive method. Moreover, little is known about the effect of irrigation management on root growth and 3D architecture.

In this study, two matric potential-based irrigation thresholds (humid, dry) were tested to determine a method to assess the effect of irrigation on root growth and architecture. The objective was to evaluate the root system evolution between the middle and the end of the growing season to observe the difference in roots development and roots architecture under different irrigation management. This experiment was performed in a greenhouse with a potato crop using a highly monitored experimental setup including two tensiometers for two potato plants, soil moisture probes and meteorological sensors controlling the greenhouse climate. Two replicates of each threshold were scanned at two different dates using a Siemens SOMATOM Definition AS+ 128 CT-scan with a resolution of 0.7 X 0.7 X0.6 mm for three different experiments using two x-ray energy levels.

Results show that an optimal X-ray energy level protocols increase image quality and allow the visualization of the root system with the selected image scanning protocols. Root tracking software can be used to reconstruct a 3D model of the root system. The resulting image shows a difference in roots architecture related to the water distribution in the soil profile. The root system from the dry treatment tends to develop tuber deeper and humid treatment tends to grow tuber closer to the surface. Indicating that root distributions tends to be shallow in humid soil conditions and deeper in dry soil conditions. Also, potato commercial yields may be affected by the tuber distribution and the root architecture. CT-scan images of the root systems are an effective method to construct 3D models and to observe phenotypic behaviors in plants to overcome the challenges of studying the roots with non-destructive temporal observations in an opaque media.