Phenotyping of the 'hidden half' – opportunities and challenges to improve water and nutrient acquisition"

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ABSTRACT:

The worldwide increased demand for plant biomass (food, feed, energy sources and fibers) must be accompanied by new concepts to improve food security at the same time. Improved water and nutrient acquisition of plants is certainly one aspect of the value web and increased biomass production within the framework of a sustainable bioeconomy. Phenotyping is the current bottleneck to accelerate plant breeding (Fiorani and Schurr, 2013), and new methods are needed to phenotype the root system in the field, with the aim to select forroot systems with increased water and nutrient acquisition. 'Shovelomics' is a 'low-tech', high-throughput method(Trachsel *et al.*, 2010) that allows the phenotyping of root crowns of single plants in large plant populations. Weadapted this method to phenotype root systems of temperate and tropical cereals for architectural and anatomical root traits in the field.We developed novel high-throughput phenotyping platforms and pipelines for root crowns of field-grown, temperate cereals, including custom-made imaging stations for temperate and tropical grasses and a semi-automated imaging processing pipeline that links into the DIRT software (Bucksch *et al.*, 2014) allowing fast phenotyping of root crowns. The methodology was used to measure variation of root traits within barley genotypes and specific groups in field experiments. The groups were based on the originof genotypes, including varieties from Norway, Germany, and Australia.A split-plot design with7repetitions was chosen to measure the existing variation within a field experiment including different levels of N-fertilization. Different root traits were extracted from the root images using the DIRT software and analyzedwith the software GenStat 18.1.This low-cost andhigh-throughput method is suited to measure root traits of temperate cereals in the field supporting pre-breeding and breeding efforts. These developments are the first steps towards an automation of field root phenotypingin the future, and are currently transferred tocassava storage root phenotyping within the framework of the CASSAVASTORe project.