Abstract

Detailed and standardized protocols for plant cultivation in environmentally controlled conditions are an essential prerequisite to conduct reproducible experiments with precisely defined treatments. Setting up appropriate and well defined experimental procedures is thus crucial for the generation of solid evidence and indispensable for successful plant research. Non-invasive and high throughput (HT) phenotyping technologies offer the opportunity to monitor and quantify performance dynamics of several hundreds of plants at a time. Compared to small scale plant cultivations, HT systems have much higher demands, from a conceptual and a logistic point of view, on experimental design, as well as the actual plant cultivation conditions, and the image analysis and statistical methods for data evaluation. Furthermore, cultivation conditions need to be designed that elicit plant performance characteristics corresponding to those under natural conditions. This manuscript describes critical steps in the optimization of procedures for HT plant phenotyping systems. Starting with the model plant Arabidopsis, HT-compatible methods were tested, and optimized with regard to growth substrate, soil coverage, watering regime, experimental design (considering environmental inhomogeneities) in automated plant cultivation and imaging systems. As revealed by metabolite profiling, plant movement did not affect the plants' physiological status. Based on these results, procedures for maize HT cultivation and monitoring were established. Variation of maize vegetative growth in the HT phenotyping system did match well with that observed in the field. The presented results outline important issues to be considered in the design of HT phenotyping experiments for model and crop plants. It thereby provides guidelines for the setup of HT experimental procedures, which are required for the generation of reliable and reproducible data of phenotypic variation for a broad range of applications.