Application of high throughput phenotyping via PlantScreen System to study early plant stress responses to progressive drought stress

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**Introduction**

Drought and salinity in soils are currently one of major problems in agriculture with rapidly growing importance in last few years. The use of advanced phenotyping that offers application of automated, high-throughput methods for characterization of plant architecture and performance has potential for improvement of breeding process of different important crops. Converger and robotic PlantScreen System developed in PSI is designed for high throughput plant phenotyping in various species from Arabidopsis to crop plants. Recently we have used the PlantScreen System to study response of various Arabidopsis stock related mutants to drought stress conditions. We have optimized the screening conditions and the image processing analysis to obtain quantitative assessment of plant complex traits such as growth, development and physiological status. By using combination of chlorophyll fluorescence imaging, thermal imaging and morpho-epiphyte image analysis we have recognized a set of parameters that could serve as early stress markers for characterization of plant performance under adverse environmental conditions such as drought.

**Methods**

PlantScreen System was used for the high-throughput automated phenotypic analysis. Plants were grown in 9cm9cm light conditions under cool-white LED illumination of 80 µmol m⁻² s⁻¹ in standard amount of grown out. When plants reached 8th leaf stage last watering was performed. 3 days later the phenotypic analysis in high-throughput PlantScreen System was initiated. For next 7-8 days RGB structural imaging, chlorophyll fluorescence and thermal imaging were monitored twice a day. Here we present data from one out of 4 biological experiments performed.

**Discussion**

Analysis of plant performance under water limiting conditions and better understanding of plant responses under drought conditions has in past years become major focus of research and investments. Primary ultimate goal of sustainable farming would be developing crops with improved water use efficiencies. Here we present rapid high-throughput non-invasive approach to assess numerous phenotypic traits of self-grown plants during progressive drought stress treatment. High-throughput phenotyping platform PlantScreen System, was used for automated weighting RGB structural analysis, kinetic chlorophyll fluorescence assessment and leaf temperature determination via thermal imaging. In addition hyperspectral analysis was used to determine water content in water-limited plants. Combustion statistical analysis was used to discriminate early drought stress marker. Here we show that the changes in light-adapted photosynthetic parameters during increasing water deficit monitored via chlorophyll fluorescence imaging can be used as primary marker for the rapid assessment and comparison of the relative viability of Arabidopsis plants during progressive drought.

**Results**

**Chlorophyll Fluorescence Imaging**

Fig. 3: Time course of chlorophyll fluorescence transients signature in control and stressed plants measured by quenching protocol after 7-8 days maximum fluorescence in light adapted state (Fig 1) differed between stressed and control group.

**Hyperspectral Imaging**

Fig. 5: Rapid rehydration stress was used to assess rate of water content loss by water absorption measurement with SNIR hyperspectral camera. Blue color refers to water content as detected by absorbance at 500 nm and 700 nm.