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We offer access to cutting edge instruments and provide professional support of highly skilled technical and scientific personnel. **PPRC** infrastructure is available for use by visiting scientists and on fee-for-service basis for a wide range of phenotyping experiments.

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PlantScreen™ Automated Phenotyping Systems

Automated integrative phenotyping of drought tolerance in barley

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Background

Drought is one of the most severe environmental stresses affecting many of the food crops and causing significant yield losses globally. Two accessions of *Hordeum spontaneum* and 31 genotypes of *Hordeum vulgare* originating from contrast climatic conditions including old and new varieties from Central Europe were tested for their tolerance to drought in PlantScreen™ automated plant phenotyping platform (Photon System Instruments, PSI). Integrative plant phenotyping approach, based on implementation of RGB imaging, kinetic chlorophyll fluorescence, hyperspectral and thermal imaging sensors, was used to quantify dynamics of drought stress induced changes in complex set of morpho-physiological traits.

Here we present results for two accessions W30 and Abyssinian 1125 showing strongly contrasting phenotypes and response to drought as well as ability to recover following re-watering phase.

Materials and Methods

Seeds were germinated on moistened filter paper for 3 days and then transplanted into pots of 3L. Plants were at tillering stage (37 days) transferred to PlantScreen™ Modular System integrated within greenhouse and divided into control (well-watered) and drought stress groups with 4 replications per genotype and treatment (A). The control group was regularly watered in automated weighing and watering unit to 70% of water holding capacity, while drought stressed group was allowed to gradually dry until wilting point (Day 20) (B). Subsequently the watering to the control group level (70% of water holding capacity) was carried out to evaluate recovery of plants for next 10 days (C). During the experiment measurements of side projected plant area using calibrated RGB camera (side view), actual quantum yield of photosystem II (Φ_{PSII}) using open fluorescence camera (top view) and leaf temperature difference to air temperature using infrared thermal camera (top view) were done in regular intervals ≤4 days (D).

Fig.4 Plant cultivation and automated phenotyping protocol

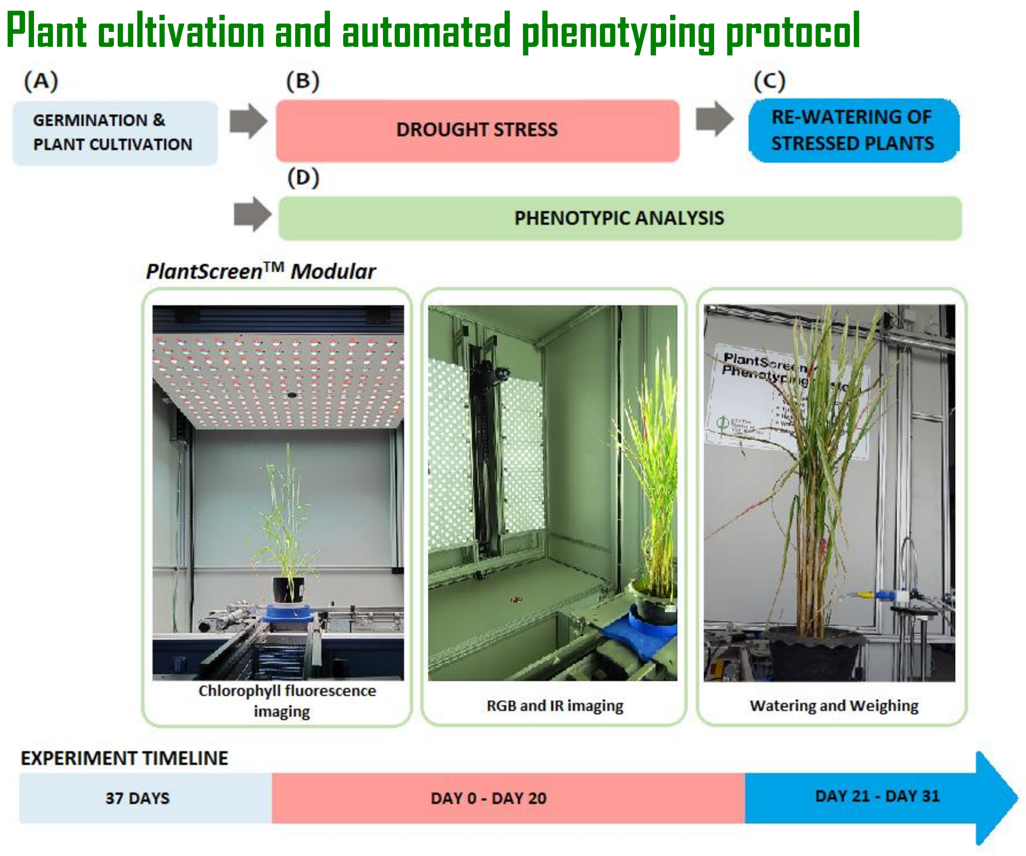
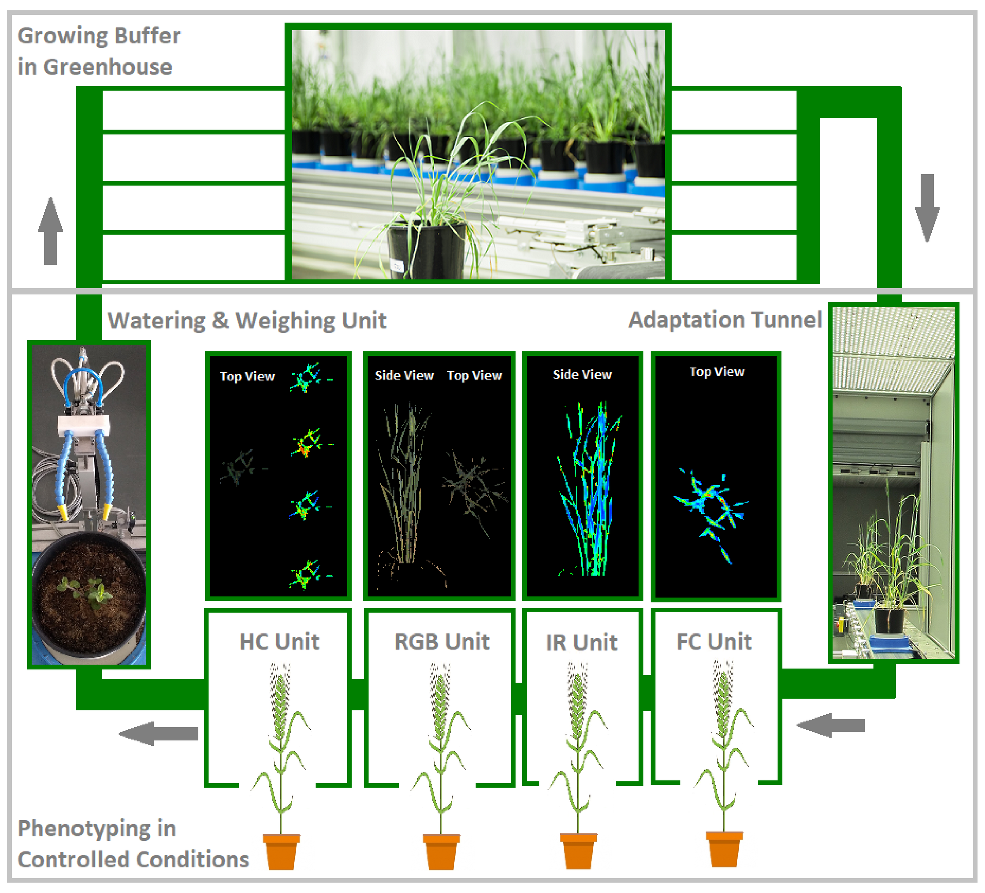


Fig.5 PlantScreen™ Modular System in PSI Research Center. Integrates visible RGB camera for top and 360°side view, kinetic chlorophyll fluorescence imaging camera (top view), thermal imaging sensor (360°side view), VNIR and SWIR hyperspectral imaging sensor (top view), watering and weighing unit and light/dark adaptation tunnel.



Results

Fig.1A Growth performance in control and drought stressed plants. Pronounced decline

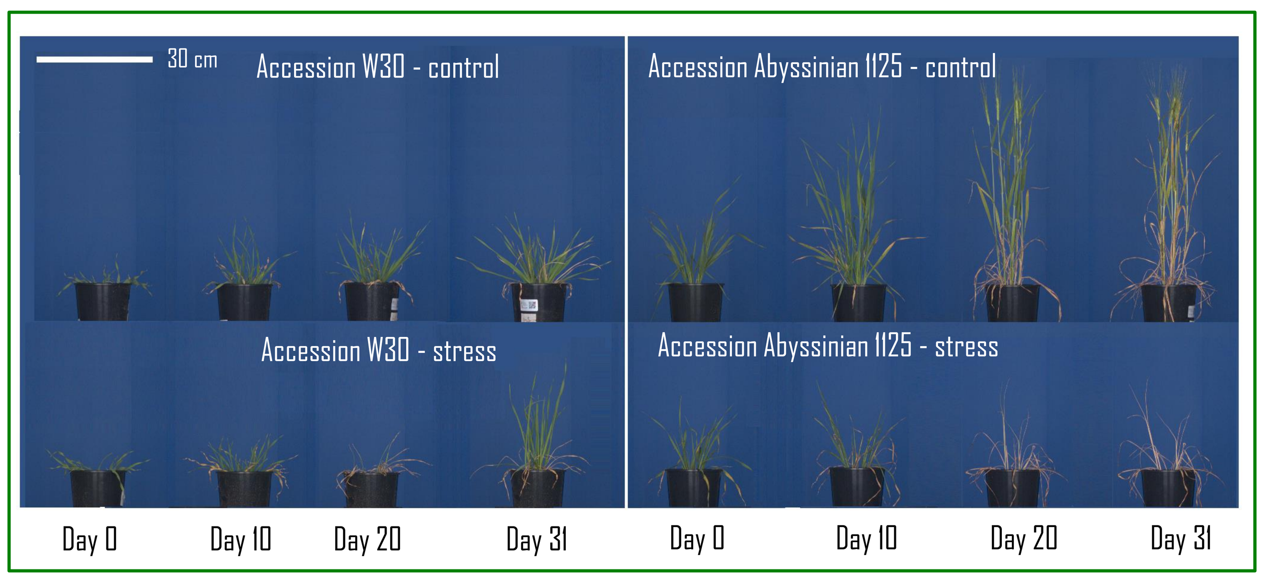


Fig.1B Pronounced decline in projected side area in drought stressed plants is almost recovered upon re-watering in resistant lines.

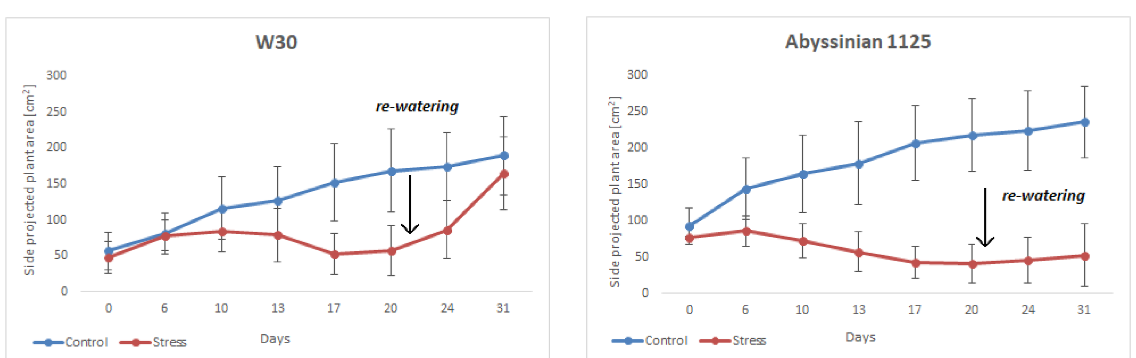


Fig.2 Leaf temperature difference to air temperature was quantified using infrared thermal camera.

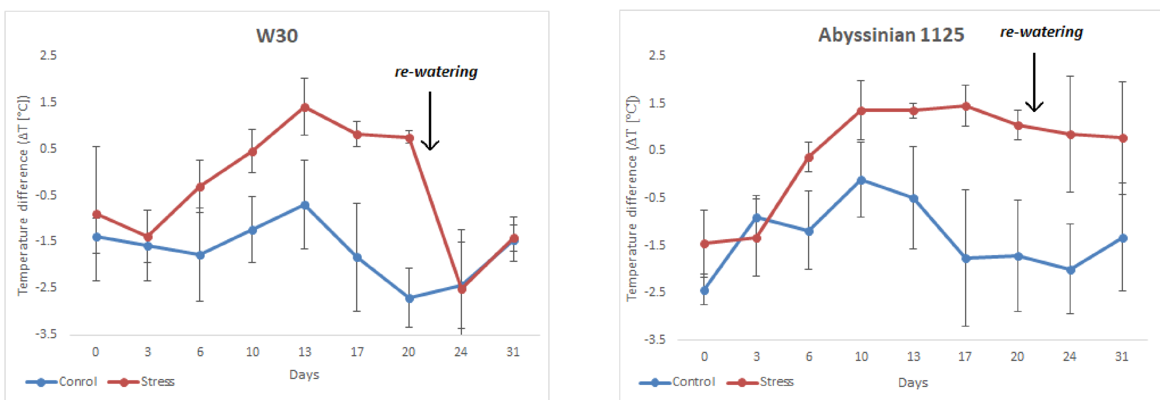
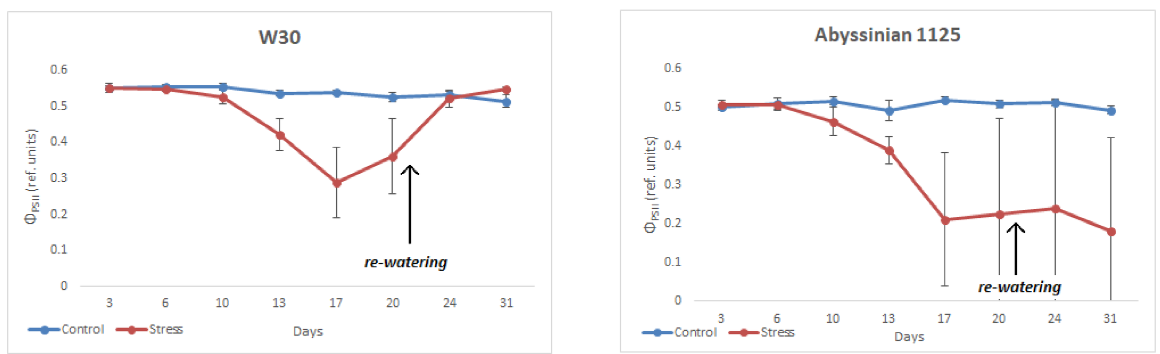


Fig. 3 Actual quantum yield of photosystem II (Φ_{PSII}) rapidly reflects level of drought stress and dynamically recovers upon re-watering in W30.



Acknowledgements

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Conclusions

Here we show that several groups of genotypes can be identified within the used barley lines. The divergence between control and drought stress group is observed in most parameters measured between days 6 and 13. In most sensitive genotypes this divergence is observed already on day 6. Three different responses were observed:

- First group of genotypes showed more pronounced decline of side projected plant area and ΦPSII compare to control plants. In this group after the re-watering no significant recovery of plant area, temperature difference and ΦPSII was observed (Abyssinian 1125 genotype).
- Second group showed slower decline of most parameters during drying out. Particularly the relative decline of ΦPSII is significantly lower when compared to drought sensitive group. Within this group also full recovery of ΦPSII and temperature difference and partial recovery of plant area were found (data not shown).
- Finally the last, most tolerant group shows complete recovery of plant area and also of ΦPSII and temperature difference. Interestingly, this group also shows greater relative decline of ΦPSII during drying out but also very rapid recovery of this parameter (W30 genotype).

Further different spectral reflectance indices to detect drought stress tolerance were quantified. In outlook, based on relationships between grain production and response to drought stress and individual parameters measured the sensitivity analysis of individual methods for drought tolerance phenotyping in crop plants will be assessed.