

## PSI Research Center Infrastructure

### Phenotyping platform for mid-size scale and large plants

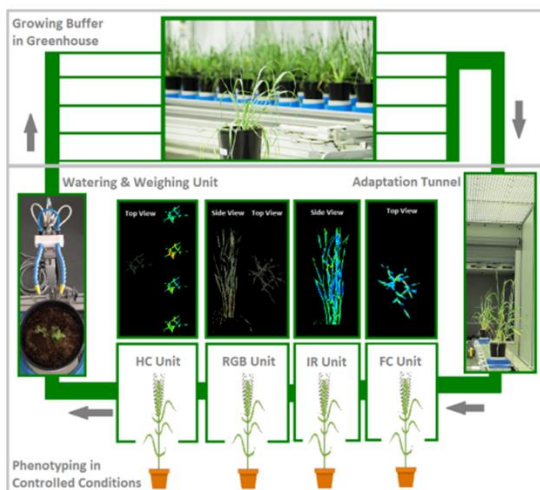
Installation name:	PSI RC 2. Large
Installation place:	PSI Research Center, Drásov, Czech Republic
Installation category:	platform under semi-controlled greenhouse environment
Environmental manipulation:	air emperature, light quantity
Trait measurements:	agronomic, chlorophyll fluorecence, growth, photosynthesis, plant structure/architecture, plant water status, plant biochemical status
References:	PAUL K, SORRENTINO M, LUCINI L, ROUPHAEL Y, CARDARELLI M, BONINI P, REYNAUD H, CANAGUIER R, TRTÍLEK M, PANZAROVÁ K, COLLA G. (2019). Understanding the Biostimulant Action of Vegetal-Derived Protein Hydrolysates by High-Throughput Plant Phenotyping and Metabolomics: A Case Study on Tomato. Front Plant Sci. 8;10:47. DOI: 10.3389/fpls.2019.00047
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### Technical specifications

Max plant height:	120 cm
Max plant width	80 cm
Max throughput:	270 plants
Max plant weight:	6 kg
Pot volume:	3L, 5L
Temperature range :	15-35°C
Supplementary illumination:	Up to 350 $\mu\text{mole/m}^2\text{s}$ PAR
Imaging units:	top and multi-angle side RGB, kinetic chlorophyll fluorecence, side view thermal camera, top view VNIR and SWIR hyperspectral camera
Others sensors:	watering and weighing unit, dark/light adaptation tunnel with max. light intensity 1500 $\mu\text{mole/m}^2\text{s}$ PAR, multiple environmental sensors

### General description

PlantScreen™ Modular System (PSI, Czech Republic) for mid-size scale and large plants up to 120 cm in height and 80 cm in diameter with throughput of 270 plants is installed in semi-controlled greenhouse environment. The platform is equipped with cultivation area in greenhouse environment and imaging/scoring area within climatized environment. Plants in transportation disks are transported throughout the glasshouse compartment and moved to imaging area with light/dark adaptation tunnel, 3 consecutive imaging units and watering/weighing unit. At the entry to the imaging area automatic plant height measuring unit is implemented for automatic sensor position adjustment. Four robotic-assisted imaging units are implemented for multiple angle high-resolution thermal imaging, Red Green Blue (RGB) imaging, kinetic chlorophyll fluorescence imaging and VNIR and SWIR hyperspectral imaging. Plants can be light/dark adapted in acclimation tunnel. Automatic height measuring unit and a weighing and watering unit are implemented. The multi-sensor setup allows to determine large number of plant traits describing the growth and developmental dynamics, plant architecture and color, photosynthetic performance of the plants, plant water relations and leaf temperature and plant biochemical status. The data management pipeline Plant Data Analyser (PSI, Drásov, Czech Republic) is used for automated data handling including pre-processing, segmentation, feature extraction and post-processing, all raw and result data being stored in SQL database.



### Imaging sensors

#### Visible RGB imaging unit

Top view camera: snapshot mode

Side view camera: line scanning mode

Multiple angle imaging: 0-360°

Resolution (MPix): 5

Resolution (H x W): 2560 x 1920 pixels

Output: 12 bit

Image frequency: 14.1 fps

#### **Thermal imaging unit**

Side view camera with homogenous light illumination source operating in line scanning mode

Multiple angle imaging: 0-360°

Resolution (H x W): 640 x 450 pixels

Spectral range: 7.5  $\mu\text{m}$  to 13  $\mu\text{m}$

Output: 16 bit

Thermal sensitivity: < 0.05  $^{\circ}\text{C}$  at 30  $^{\circ}\text{C}$

Image frequency: 50 Hz

#### **Chlorophyll fluorescence imaging unit**

Top view camera with light panel supplementing saturating light up to 6000  $\mu\text{mol m}^{-2}\text{s}$ , actinic light up to 2000  $\mu\text{mol m}^{-2}\text{s}$  and pulse-modulated short duration flashes.

Resolution (H x W): 720 x 560 pixels

Output: 12 bit

Frame rate: 50 fps

#### **VNIR hyperspectral imaging unit**

Top view camera with illumination source

Spectral range: 350 - 900 nm

Wavelength resolution, FWHM: 0.8 nm

Spatial resolution: 1000 pixels (max 1000 pixels)

Spectral resolution: 1920 pixels (max 1920 pixels)

Image frequency: 45 fps

#### **SWIR hyperspectral imaging unit**

Top view camera with illumination source

Spectral range: 900-1700 nm

Wavelength resolution, FWHM: 2 nm



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Spatial resolution: 510 pixels

Spectral resolution: 363 pixels

Image frequency: 50 fps