



PLANTSCREEN™ SYSTEMS

Installation Overview

MAP

Global Installations of PlantScreen™ Systems



- | | | | |
|--|---|---|--|
|  Modular System |  XYZ System |  Robotics System |  SC Mini System |
|  SC System |  Compact System |  Rover System |  Root System |
|  XY System |  Transect System |  Field System |  SC Root System |



University College Dublin
An Coláiste Ollscoile, Baile Átha Cliath



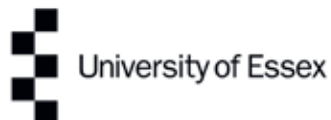
MAX PLANCK INSTITUTE
FOR PLANT BREEDING RESEARCH



HELSINGFORS UNIVERSITET



TEL AVIV
UNIVERSITY



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PlantScreen™ Phenotyping Systems

PlantScreen™ phenotyping systems represent the pinnacle of automated plant analysis technology, offering high-throughput, ultra-precise monitoring of above and below-ground traits across a range of species, from *Arabidopsis* to large crops.

The fully automated, modular platforms are powered by cutting-edge imaging sensors—including multispectral chlorophyll fluorescence, top and side RGB, hyperspectral (VNIR/SWIR), thermal, and 3D laser scanners—integrated into light-insulated imaging cabinets.

A powerful and comprehensive software package underpins the entire operation, featuring a user-friendly graphical interface, advanced experimental design tools, and complete control over system hardware and environmental monitoring, including advanced image analysis. Operated via a high-end industrial PCs, the software includes a flexible scheduling assistant with calendar functionality, enabling simultaneous experiments with customizable randomization, treatment protocols, and plant handling regimes such as dark/light adaptation or precise irrigation and nutrient delivery.



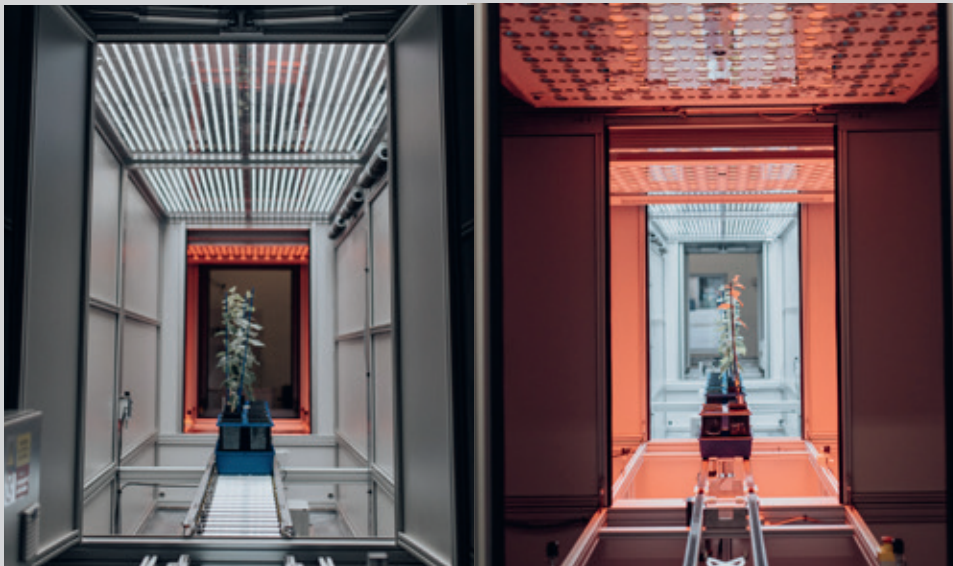
PlantScreen™ systems operate primarily under the “plant-to-sensor” concept, where plants are transported via conveyor belts from growth zones to imaging areas, but also support a “sensor-to-plant” approach, such as the PlantScreen™ Robotic XYZ system, which brings sensor arrays to predefined plant locations at scheduled intervals. Both configurations enable high-throughput phenotyping with neural network-based image analysis and RFID/barcode tracking, while accommodating various pot sizes, *in vitro* setups, hydroponics, and complex experimental layouts.

CUTTING-EDGE IMAGING SENSORS WITH PROGRAMMABLE OPERATION SCHEMES

CUTTING-EDGE NEURAL NETWORKS BASED IMAGE ANALYSIS

MODULAR WATERING AND WEIGHING STATIONS WITH NUTRIENT MIXING OPTIONS

ONLINE ENVIRONMENTAL CONDITION MONITORING

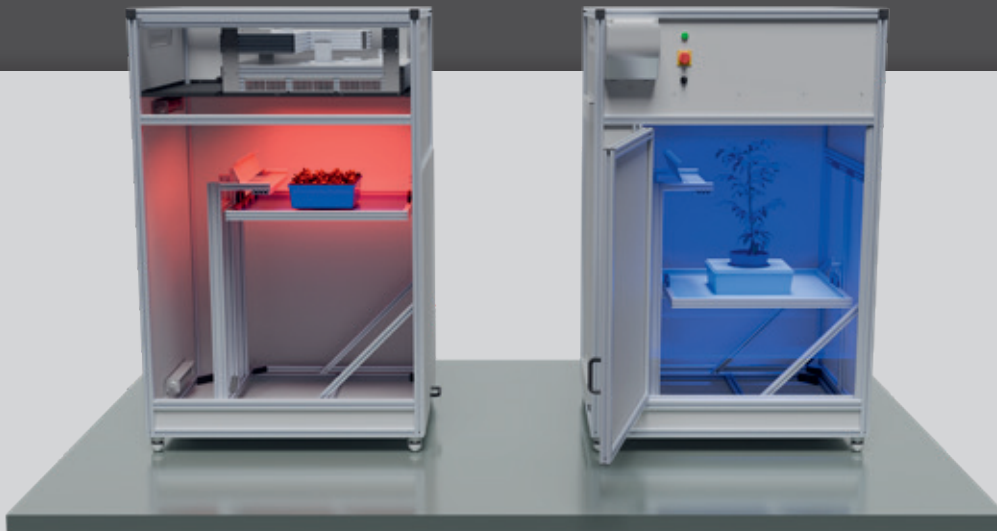


PlantScreen™ Phenotyping Systems

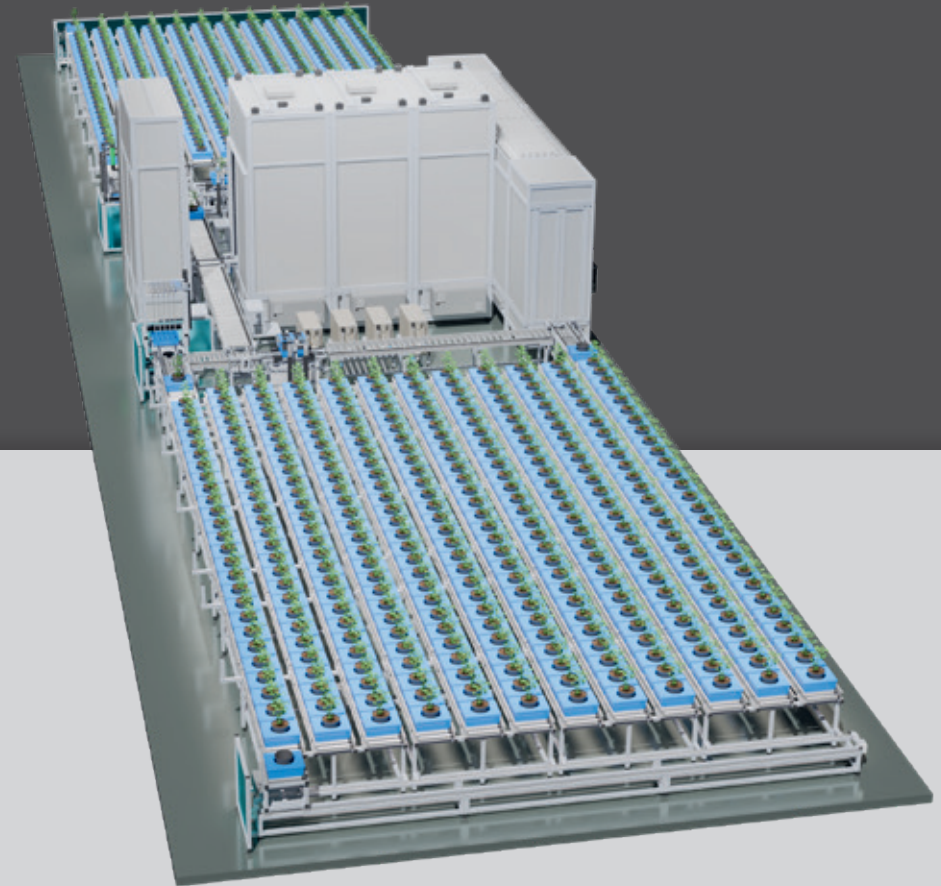
“Plant-to-Sensor concept”

PlantScreen™ phenotyping systems operating in “**Plant-to-sensor concept**” are automated systems offering unparalleled precision in plant phenotyping technology.

PlantScreen™ phenotyping systems are designed as modular fully autonomous front-to-end solutions for phenotyping of above-ground and/or below-ground properties of plants from *Arabidopsis* to crops.



PlantScreen™ SC Mini System



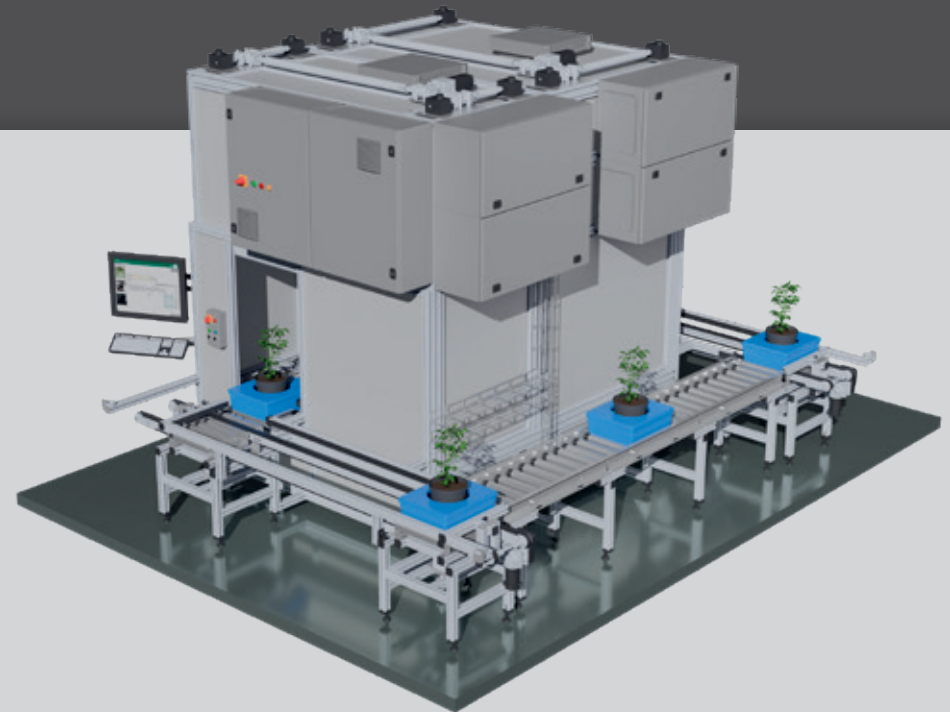
PlantScreen™ Modular System

Plants are transported on conveyor belts from the loading zone or growth area to the imaging area equipped with automatically operated state-of-the-art sensors integrated into light-insulated imaging cabinets. **PlantScreen™ transportation trays** with modular design options for pots from 250 ml to 5L including customized versions for e.g. multiwell plates are used for efficient transportation of plants up to 150 cm in height from the growing zone to the imaging units and automated plant handling zones as irrigation or spraying units.



PlantScreen™ SC Systems

Cutting-edge imaging sensors include multispectral chlorophyll fluorescence, top and side RGB, top VNIR/SWIR hyperspectral, top or side thermal and top or side 3D laser scanner. The imaging units are usually physically separated from the growth area facilitating the parallelization of measurements via a sample loop and thus improving the throughput, randomization flexibility and sensor utilization.



PlantScreen™ SC Systems

PlantScreen™ phenotyping systems

“Sensor-to-Plant concept”

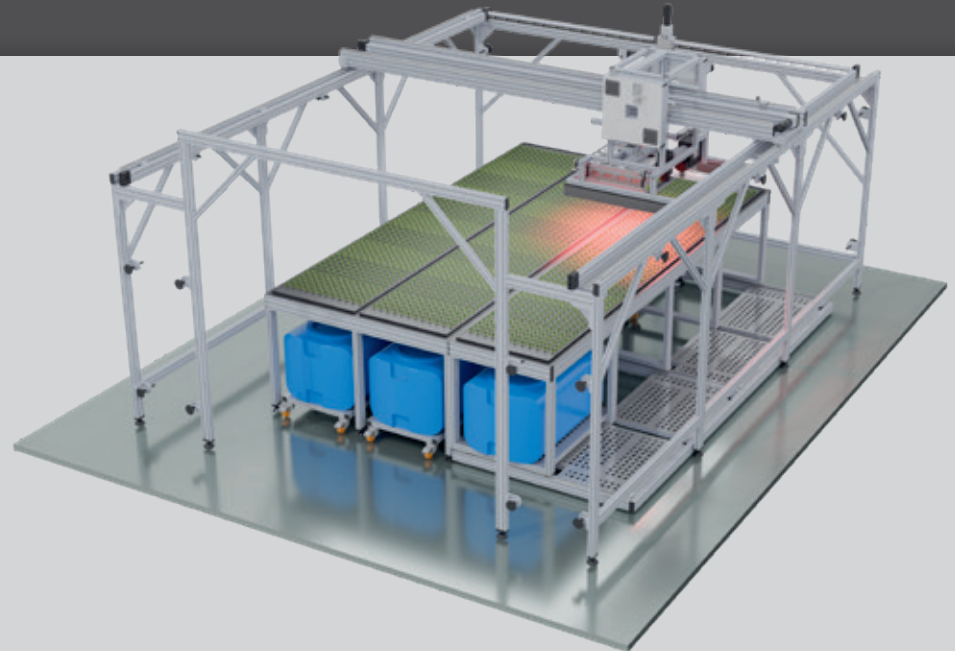
PlantScreen™ phenotyping systems, based on the “**Sensor-to-Plant concept**”, are automated platforms designed as modular, autonomous robotized end-to-end solutions optimized for the high-throughput analysis of above-ground plant traits, from small model species like *Arabidopsis* cultivated in controlled environment to large crop plants grown in greenhouse or field conditions.

PlantScreen™ Robotic XY/XYZ Systems are programmed to move the imaging array sequentially between the pre-defined locations and measure

range of morphological and physiological parameters in defined intervals. PlantScreen™ systems, based on the “**Sensor-to-Plant**” concept cover phenotyping solutions integrated into large-scale cultivation environments such as PhenoSphere cultivation hall in IPK Gatersleben in Germany and Walk-In PhytoScope Chambers in NPEC Waheningen, or autonomous complex FieldScreen™ system for automated field phenotyping. XY/XYZ robot or other carrier module brings multi-sensoric platform towards the plants or plots at defined intervals.

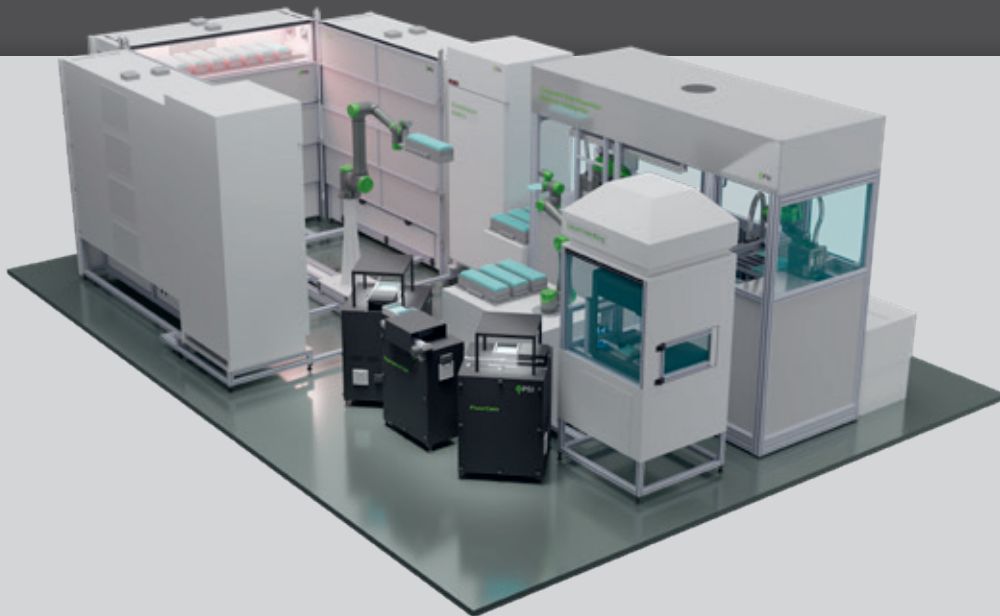
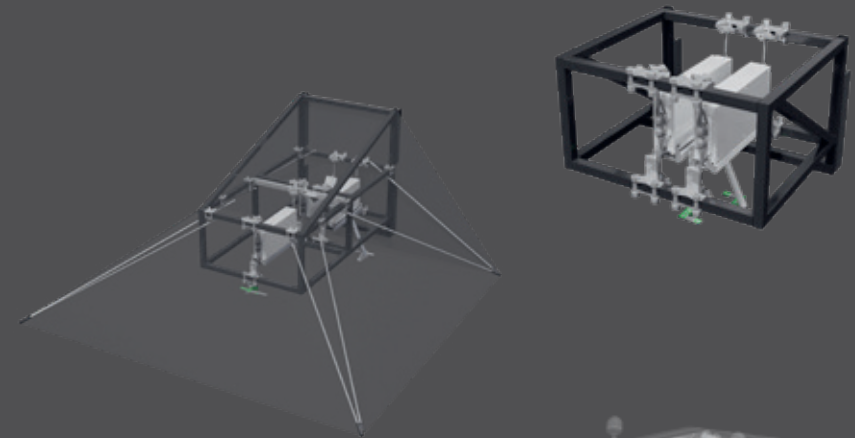


PlantScreen™ SC Mobile System



PlantScreen™ XYZ System

Configurable solutions for *in vitro* cultivation, specific pots sizes or cultivation tables (e.g. hydroponics) can be accommodated. Digital data are acquired typically from top view. Various modules for digital analysis of plant growth dynamics and physiological performance can be integrated. Combined weighing/watering station maybe implemented for precise irrigation or nutrient delivery schemes. Unique bar-code or RFID identifiers are used for plant identification.



PlantScreen™ Robotics System Hades



PlantScreen™ Field System

PlantScreen™ phenotyping systems

Applications & Case Studies

Single and combined stress response analysis in potato



Comprehensive molecular and physiological high-throughput performance profiling of potato (*Solanum tuberosum*, cv. Désirée and Lady Rosetta) under single (heat, drought, and waterlogging) stress and under combined stress mimicking future climate scenarios.

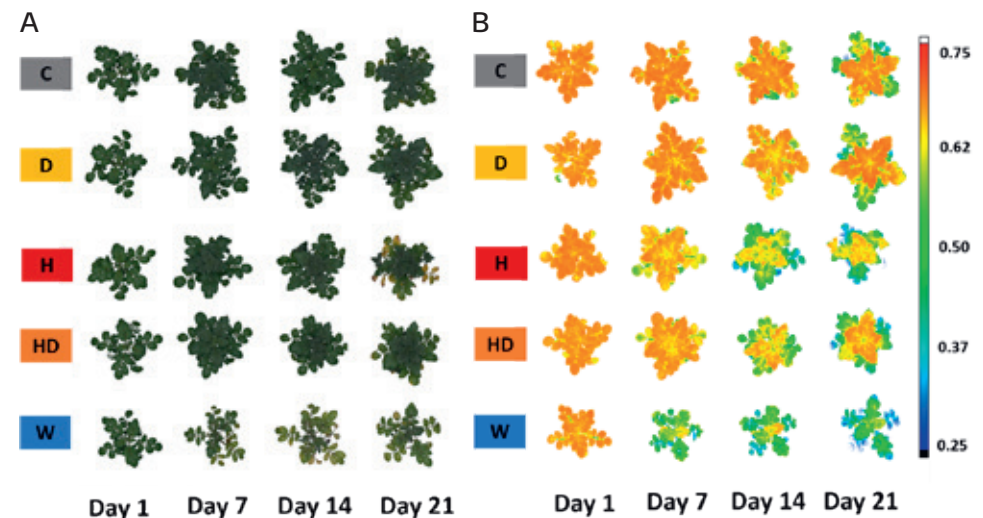
Daily phenotyping using multiple imaging sensors was conducted to monitor morphological and physiological responses. Key insights: Combining phenomics analysis (e.g. growth rate, photosynthesis rate, canopy temperature) with multi-omics analyses of harvested leaf samples provides deeper insights into plant stress responses.



Platform: PlantScreen™ Modular System

Experimental design: 2 cultivars, 6 treatments, 110 plants, 3 weeks

Reference: Zagorcak M. et al. (2025). Plant Physiol. 197(4)



A) Top view RGB images at selected time points and B) pixel by-pixel false color images of photosystem II operating efficiency captured by kinetic chlorophyll fluorescence measurement. C-control, D-drought, H-heat, HD-combined heat and drought, W-waterlogging. Days refer to days after stress initiation.

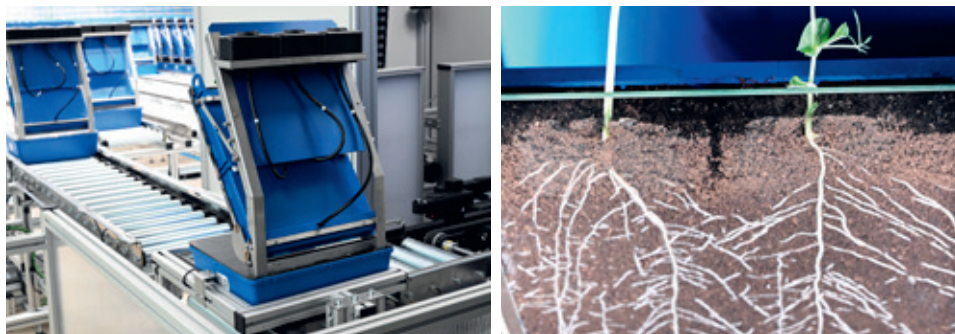
All experiments were conducted at PSI Research Center Phenotyping Facility.

Characterization of above- and below-ground heat stress responses in *Arabidopsis*



To investigate the mechanisms regulating temperature responses across all developmental stages in different *Arabidopsis thaliana* lines both root and shoot integrative phenotyping was used.

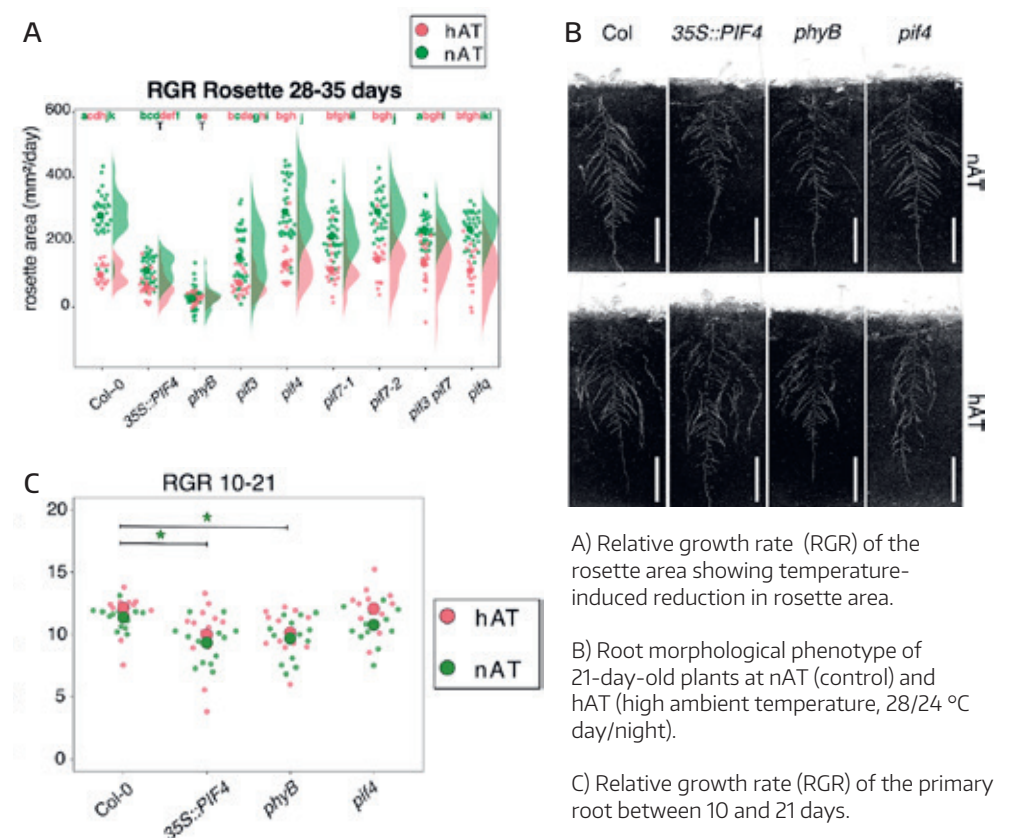
Our results show that high ambient temperatures alter the timing of developmental events, such as flowering, and affect growth patterns, including shoot and root system architecture. By using combined dynamic root and shoot phenotyping approach we could identify key regulatory pathways associated with reduced fertilization rates in wild-type plants under high-temperature conditions.



Platform: PlantScreen™ Compact System

Experimental design: 14 lines, 2 treatments, 165 plants

Reference: Ebrahimi et al. (2024). BMC Plant Biol 24, 721



PlantScreen™ phenotyping systems

Applications and case studies

Identification of drought resilience strategies in pine tree populations

In this study, we monitored the offspring of three locally adapted Scots pine populations from the Czech Republic. To evaluate their response to reduced watering, a controlled greenhouse experiment was conducted. Reduced watering was applied to 405 two-year old seedlings at the start of the vegetation season followed by a recovery period.

Results define specific functional needle traits -such as steady-state PSII quantum yield, maximum quantum efficiency of PSII, steady-state non-photochemical quenching, relative needle chlorophyll content, and ΔT , as key traits responding to early-season water reduction and subsequent summer rewatering. Importantly, we assessed the genetic variation in these traits both among and within populations.



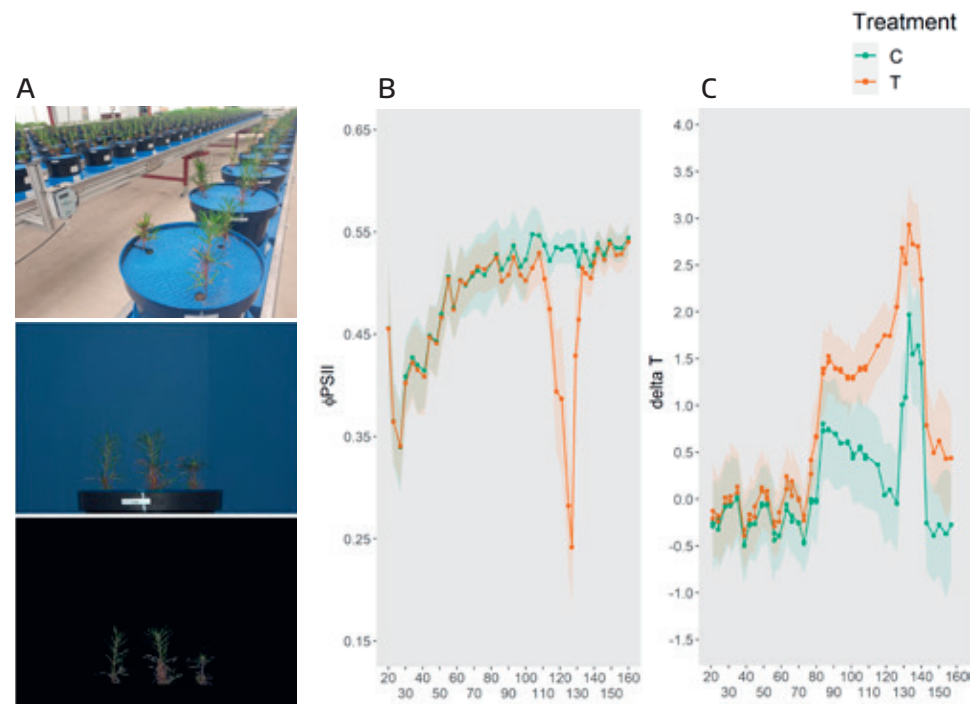
Platform: PlantScreen™ Modular System

Experimental design: 3 populations, 2 treatments, 810 plants, 14 weeks

Reference: Neuwirthova et al. (2025). Submitted.



Faculty of Science
Charles University



A) From top, RGB images of pine trees in greenhouse, side view raw and processed RGB image.

B) photosystem II operating efficiency captured by kinetic chlorophyll fluorescence measurement in control (C) and drought treated (T) plants.

C) whole plant canopy temperature captured by thermal imaging.

All experiments were conducted at PSI Research Center Phenotyping Facility.

Drought stress tolerance ranking and harvest traits prediction in Barley CMPP population using HTP and advanced modelling approaches



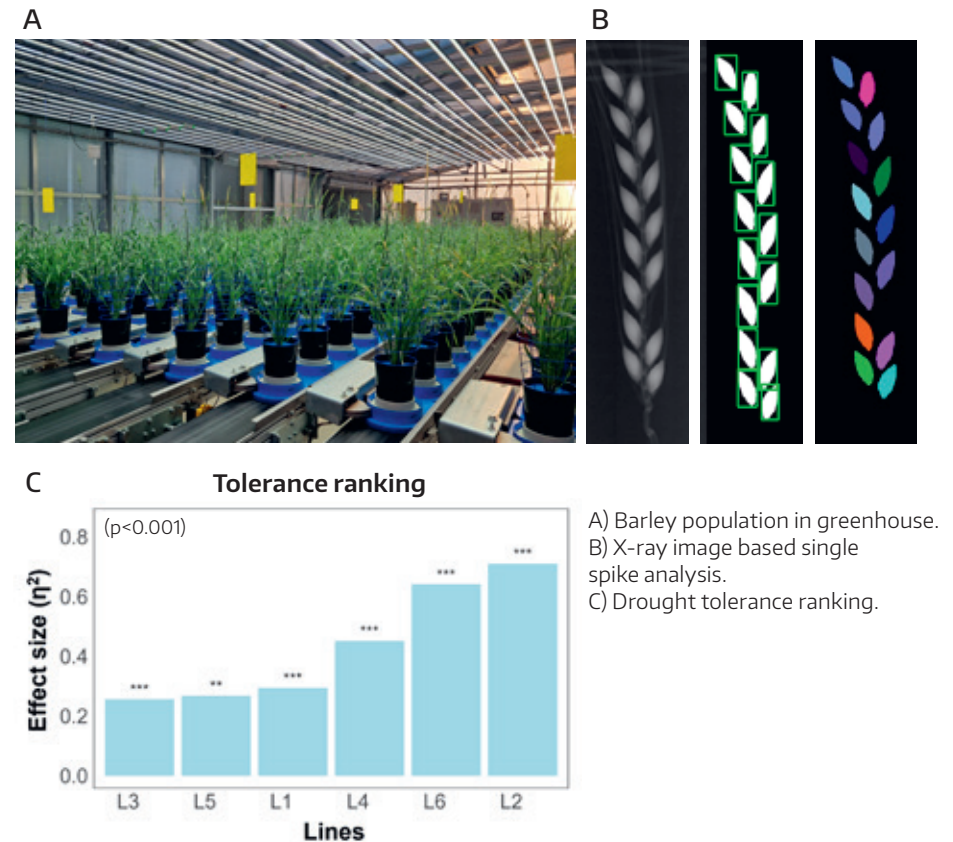
Barley lines grown under control and drought conditions were phenotyped daily throughout all developmental stages using RGB, thermal, hyperspectral and chlorophyll fluorescence imaging, including final harvest yield analysis. Overall 145 traits were extracted over 70 time points. We employed advanced data analysis and machine learning to enhance data integration and identify key traits linked to crop resilience.

Our temporal phenomic models accurately distinguished treatments ($R^2 \geq 0.97$) and predicted with high precision harvest traits like total biomass dry weight ($R^2 = 0.97$), highlighting RGB traits as key indicators. During the early reproductive stage, following drought stress imposition, rapid canopy temperature depression was identified as an important trait for distinguishing between control and drought-treated plants. Using Permanova genotype tolerance ranking was applied allowing for identification of resilient genotypes under stressed conditions.

Platform: PlantScreen™ Modular System

Experimental design: 9 genetic lines, 2 treatments, 268 plants

Reference: Tietze et al. (2025). bioRxiv 2025.05.29.656856



PLANTSCREEN™ MODULAR SYSTEM

JAMES HUTTON INSTITUTE, DUNDEE, SCOTLAND

The PlantScreen™ Modular System is designed for high-throughput phenotyping of mid-size crop plants with dimensions up to 150×60 cm. Five climate rooms are independently controlled and connected with conveyor roller transportation system enabling fully automatic and programmable transportation between **4 cultivation climate chambers** and **1 imaging section** of the phenotyping system. The throughput of the system is **52 transportation trays per compartment** (204 in total) corresponding to a maximum of 4080 plants with 5×4 pots per tray setup. The imaging sensors include **multispectral chlorophyll fluorescence**, **RGB** and **VNIR/SWIR hyperspectral units**.

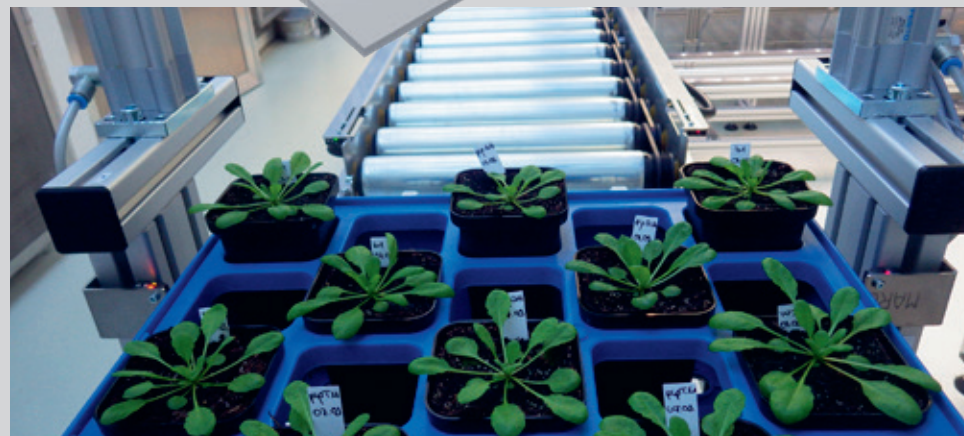
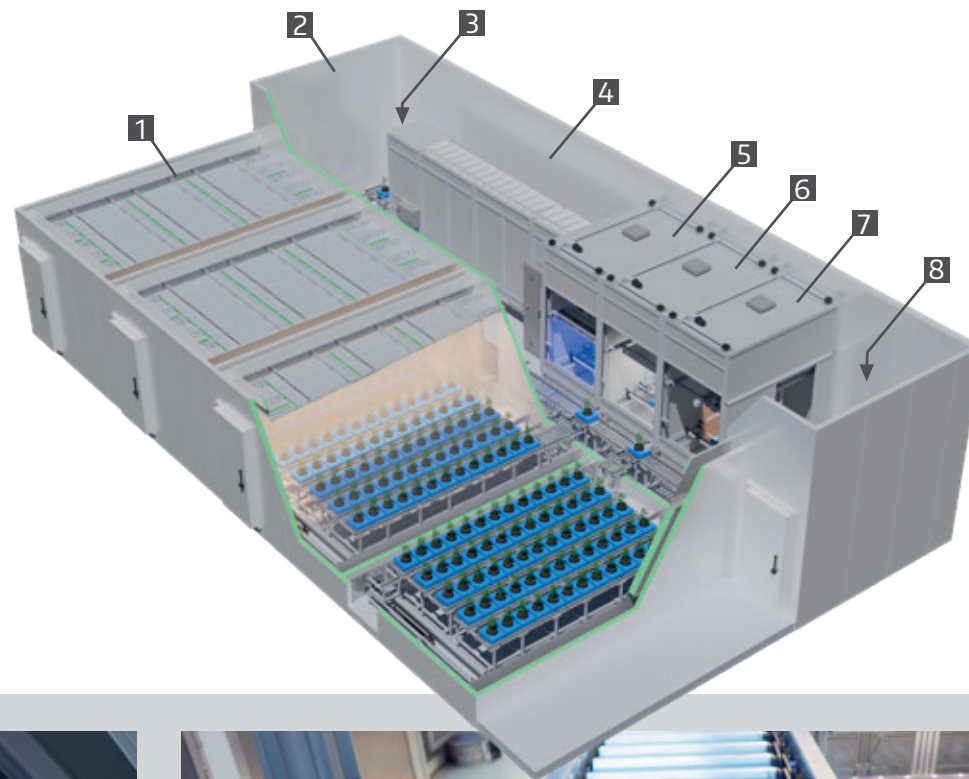


System Specifications

Type of the system	Modular
Capacity of the system	204 trays
Tray types	2×1 (3 l pots), 2×2 pots (2 l pots), 1×1 (5 l pots)
Plant size	150×60 cm
Rating and applications stations	Multispectral chlorophyll fluorescence imaging RGB morphometric imaging from top and side view VNIR/SWIR hyperspectral imaging
Environmental sensors	Light intensity, temperature and humidity pH, T for watering units

Layout Schematics

- 1 Cultivation areas
- 2 Imaging area
- 3 Load/unload area
- 4 Light/dark adaptation tunnel
- 5 Multispectral chlorophyll fluorescence imaging
- 6 RGB morphometric imaging
- 7 VNIR/SWIR hyperspectral imaging
- 8 Watering & Weighing



2025

PLANTSCREEN™ ROOT SYSTEM

PSI RESEARCH CENTER, CZECH REPUBLIC

Root system is designed as upgrade of standard PlantScreen™ shoot phenotyping system integrating rhizobox cultivation units specifically developed for simultaneous root and shoot phenotyping of crops up to 60 cm in height.

PlantScreen™ Root System is fully automated platform integrating high-resolution **RGB imaging sensors** for both shoot and root phenotyping. In addition **NIR imaging unit** is integrated for water content estimation in the rhizobox. **High-precision irrigation** system is integral part of the system for programmable delivery of both water and nutrients to either top, middle or bottom of the rhizobox.

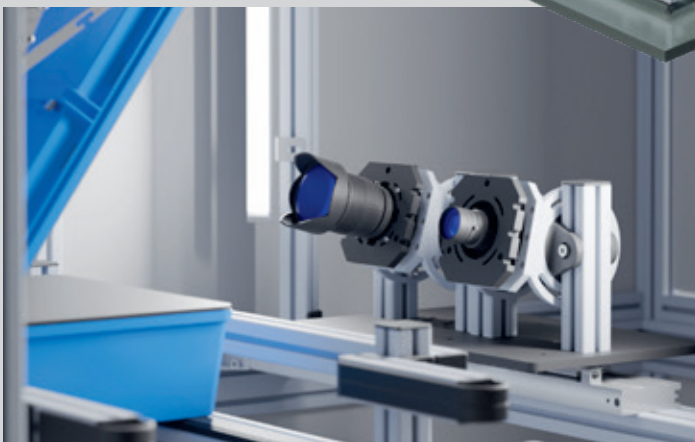
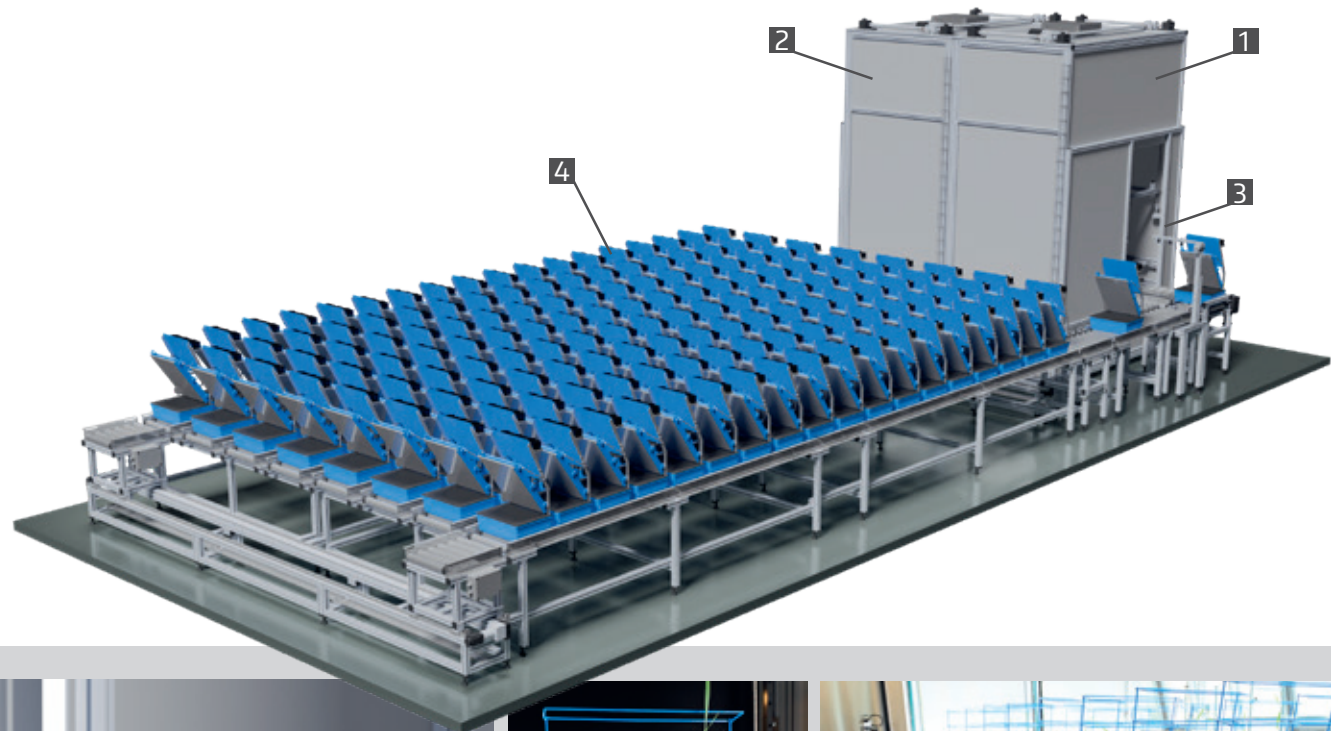


System Specifications

Type of the system	Root
Capacity of the system	140 trays
Tray types	Rhizobox
Plant size	60×40 cm
Rating and applications stations	RGB morphometric imaging from top and side view Root imaging VNIR imaging
Environmental sensors	Light intensity, temperature and humidity pH, T for watering units

Layout Schematics

- 1 RGB shoot imaging unit
- 2 Root RGB/NIR imaging unit
- 3 Watering & Weighing
- 4 Cultivation buffer



2024

PLANTSCREEN™ MODULAR SYSTEM

UNIVERSITY OF LIFE SCIENCES LUBLIN, POLAND

PlantScreen™ Modular System with capacity of **726 trays** is installed inside of greenhouse with **imaging area in the middle** of the area and **two cultivation areas** each with capacity of **363 trays**. The imaging area integrates **adaptation tunnel** and **imaging compartments** plus two types of **watering and weighing units** for each cultivation area. In addition **spraying unit** is integrated that can be used for any plant grown in both of the cultivation areas. Maximum plants size is **150 cm in height and 50 cm in width**.

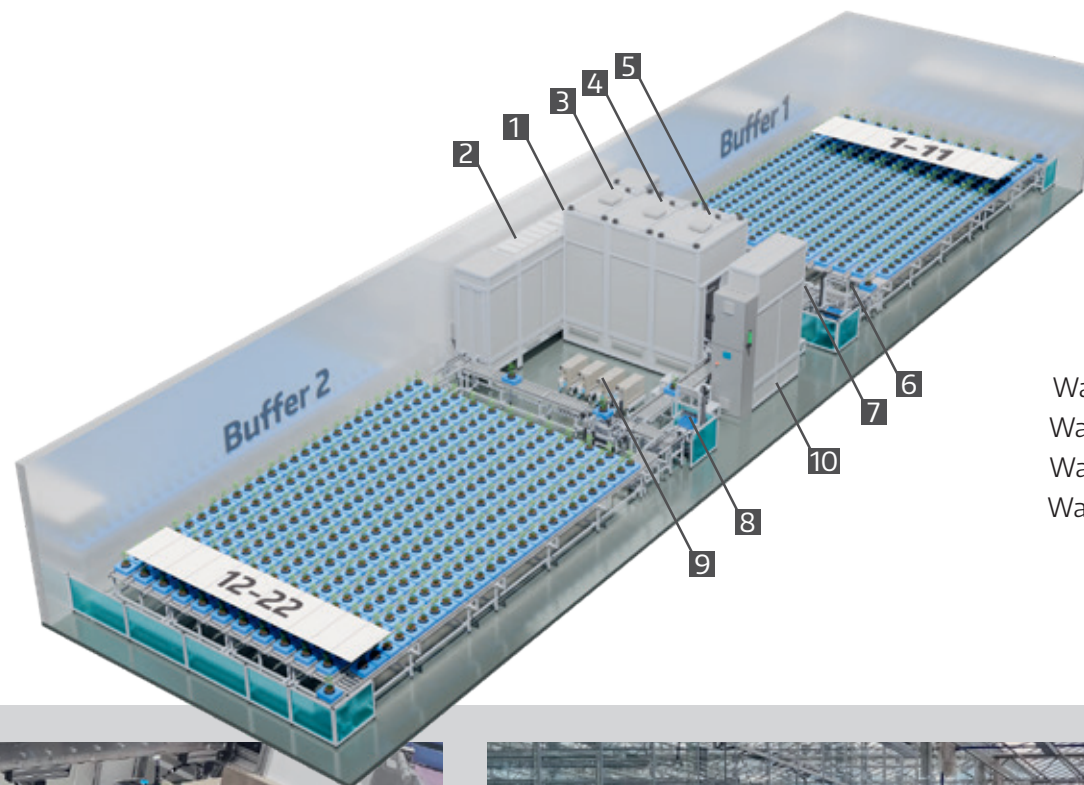


System Specifications

Type of the system	Modular
Capacity of the system	726 trays (363 trays per cultivation compartment)
Tray types	1x5 l pot / 2x3 l pot / 4x2 l pot / 20x0.25 l pots
Plant size	150x50 cm
Number of lines in growing buffer	2x11 lines
Adaptation chamber illumination	Cool white (intensity 500 $\mu\text{mol}/\text{m}^2/\text{s}$)
Rating and applications stations	Chlorophyll fluorescence imaging, RGB Morphometric imaging from top and side view VNIR/SWIR hyperspectral imaging 2x watering and weighing unit Spraying unit
Environmental sensors	Light intensity, temperature and humidity pH, T for watering units

Layout Schematics

- 1 Adaptation 1
- 2 Adaptation 2
- 3 Chlorophyll fluorescence imaging
- 4 RGB, 3D scanning
- 5 VNIR/SWIR hyperspectral imaging



- Watering & weighing station 1 6
- Watering & weighing station 2 7
- Watering & weighing station 3 8
- Watering & weighing station 4 9
- Spraying unit 10



2024

PLANTSCREEN™ XYZ SYSTEM IN WALK-IN CHAMBER

ESSEX PLANT INNOVATION CENTRE (EPIC), UNIVERSITY OF ESSEX, UK

PlantScreen™ XYZ System for plants up to 40 cm in height is installed inside of large-scale cultivation chamber with imaging area of 4800x5200 mm. Robotic imaging module includes PAM chlorophyll fluorescence plus multi-color imaging unit, RGB morphometric imaging, VNIR and SWIR hyperspectral imaging and thermal imaging. Maximum plants size is **40 cm in height and 45 cm in width**.



University of Essex

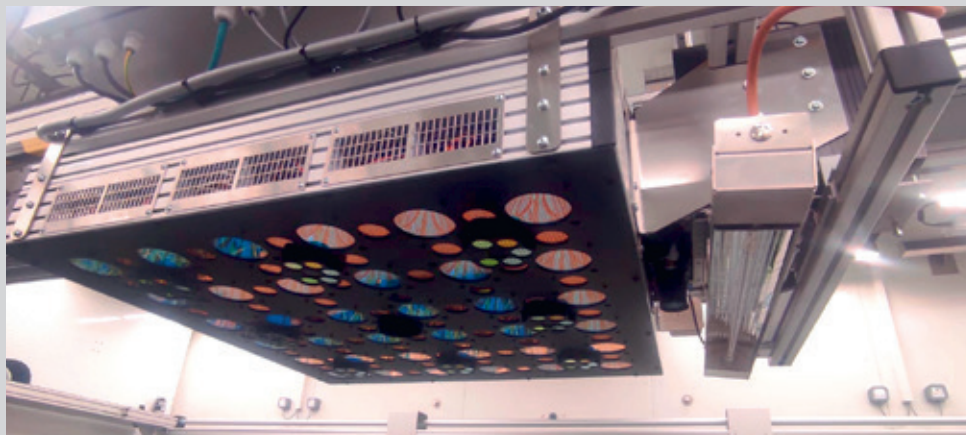
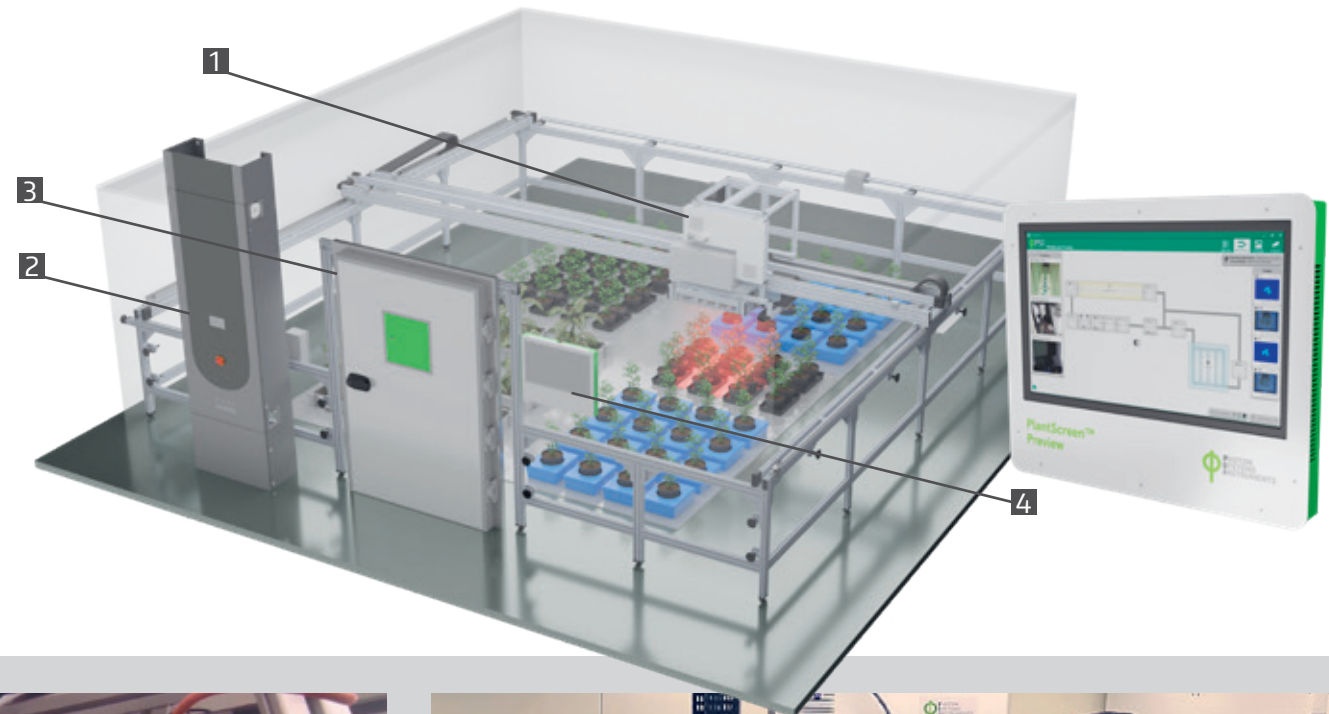


System Specifications

Type of the system	XYZ
Capacity of the system	4800x5200 mm
XY axis range	X: 4460 mm Y: 4860 mm Z: 405 mm
Plant size	40x45 cm
Rating and applications stations	Chlorophyll fluorescence imaging RGB morphometric imaging VNIR hyperspectral imaging SWIR hyperspectral imaging Thermal imaging
Environmental sensors	Light intensity, temperature and humidity

Layout Schematics

- 1 Imaging module with: Chlorophyll fluorescence imaging, RGB, IR, SWIR and VNIR sensors
- 2 Control panel
- 3 Door
- 4 PS preview



2024

PLANTSCREEN™ MODULAR SYSTEM IN WALK-IN CHAMBER

MAX-PLANCK-INSTITUT FOR PLANT BREEDING RESEARCH, KÖLN, GERMANY

PlantScreen™ Modular System with capacity of **176 trays** is installed inside of large-scale walk-in chamber divided into two individually controlled compartments;
1. **imaging compartment** with all imaging and application units, and 2. large **cultivation compartment**. The system comprises customized **nutrient mixing units** with integrated pH and EC sensors. Maximum plants size is **100 cm in height and 50 cm in width**.

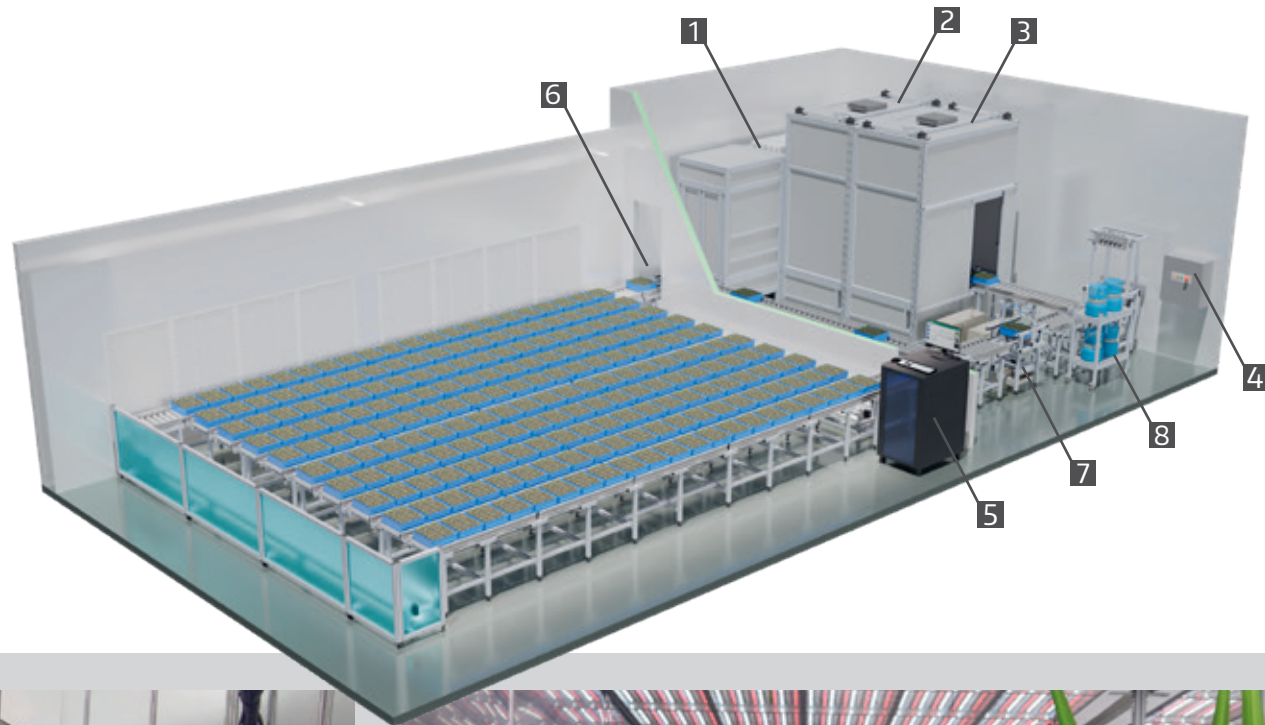


System Specifications

Type of the system	Modular
Capacity of the system	176 trays
Tray types	1x5 l pot / 2x3 l pot / 4x2 l pot / 20x0.25 l pots
Plant size	100×50 cm
Number of lines in growing buffer	9
Adaptation chamber illumination	Cool white (Maximum intensity 500 $\mu\text{mol}/\text{m}^2/\text{s}$)
Rating and applications stations	Chlorophyll fluorescence imaging RGB morphometric imaging from top and side view 2x watering and weighing unit Mixing units
Environmental sensors	Light intensity, temperature and humidity pH, T, EC for WW/Mixing units

Layout Schematics

- 1 Adaptation chamber
- 2 Chlorophyll fluorescence imaging
- 3 RGB Structural imaging station
- 4 Main control panel
- 5 PC cabinet with HMI control panel
- 6 Loading area
- 7 Watering & Weighing 1
- 8 Watering & Weighing 2



PLANTSCREEN™ SC MOBILE SYSTEM

NATURAL RESOURCES INSTITUTE FINLAND (LUKE), TURKU, FINLAND

PlantScreen™ SC Mobile System integrates **high-sensitivity kinetic chlorophyll fluorescence imaging unit with Tomi-2** (high-resolution for PAM imaging) or Tomi-3 (high-speed for OJIP imaging) cameras, **RGB structural imaging unit** and **thermal imaging unit** all mounted on imaging panel for both top and side view imaging. It consists of rover frame on wheels for system transportation and imaging panel height adjustment. Integrates all network components, Mini application server with DB and environmental sensors. Maximum plants size is **120 cm in height and 40 cm in width**.

Links:

<https://www.luke.fi/en/projects/kuka>

References:

PUNKKINEN M., BLOKHINA O., PERALTA L. L., ET AL. (2024).

Mitochondria affect photosynthesis through altered tissue levels of oxygen. BioRxiv 07.19.604342.

DOI: 10.1101/2024.07.19.604342

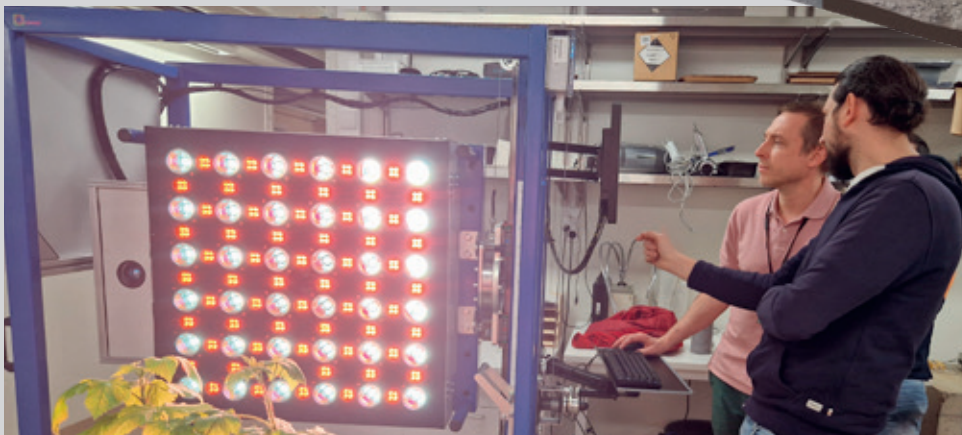
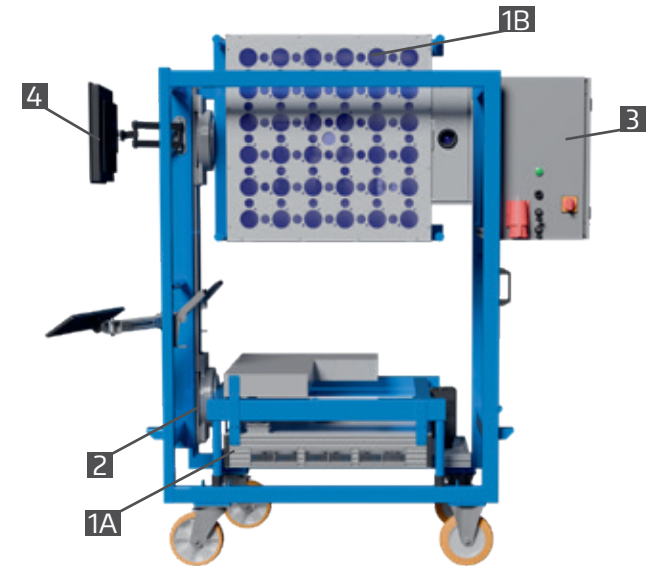


System Specifications

Type of the system	SC Mobile
Capacity of the system	1 - 2 trays
Tray types	Not defined
Plant size	120×40 cm
Rating and applications stations	Chlorophyll fluorescence imaging with 2 exchangeable cameras (Tommi-2 and Tommi-3) RGB morphometric imaging, Thermal imaging
Environmental sensors	Light intensity, temperature and humidity

Layout Schematics

- 1A Imaging module in horizontal position
- 1B Imaging module in vertical position
- 2 Crunk lift system
- 3 Control cabinet with PC
- 4 PC monitor and peripherals



2023

PLANTSCREEN™ SC SYSTEM

JAMES HUTTON INSTITUTE, DUNDEE, SCOTLAND

The system is designed for small-scale fully automated phenotyping of mid-size crop plants with dimensions up to 70×50 cm. The system includes imaging loop with all imaging units including multispectral chlorophyll fluorescence, RGB, SWIR hyperspectral, thermal and 3D.



System Specifications

Type of the system	SC
Capacity of the system	5 trays
Tray types	5×4 (250 ml pots), 2×2 (2 l pots), 1×1 (5 l pots)
Plant size	70×50 cm
Rating and applications stations	Multispectral chlorophyll fluorescence imaging RGB morphometric imaging from top and side view 3D laser scanning Thermal imaging SWIR hyperspectral imaging
Environmental sensors	Light intensity, temperature and humidity

Layout Schematics

- 1** Imaging box 1 - multispectral chlorophyll fluorescence imaging, RGB morphometric imaging, thermal imaging, 3D laser scanning
- 2** Imaging box 2 - SWIR hyperspectral imaging, RGBS camera
- 3** Control cabinet
- 4** Secondary control panel
- 5** Control PC
- 6** Loading/unloading position
- 7** QR code reader



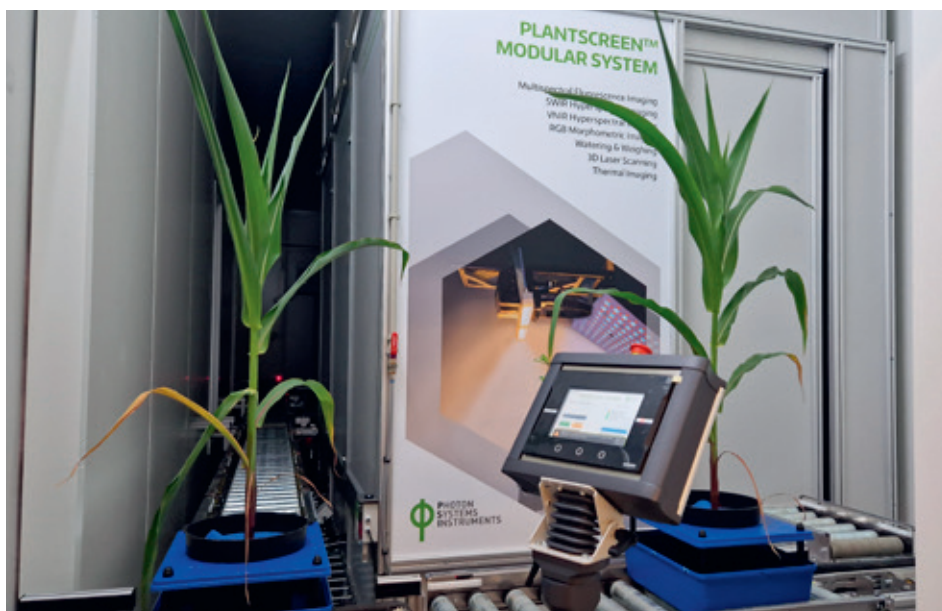
2023

PLANTSCREEN™ MODULAR SYSTEM IN WALK-IN CHAMBER

CENTER FOR AGRICULTURAL RESEARCH (ATK), HUNGARY

PlantScreen™ Modular System with capacity of **230 trays** is installed inside of three large-scale walk-in chambers divided into three individually controlled compartments; **imaging compartment** with all imaging and application units, and two large independently controlled **cultivation compartments** with individually integrated **watering and weighing unit**. Maximum plants size is **150 cm in height** and **50 cm in width**.

Links: <https://atk.hun-ren.hu/en/phenotyping-system/>

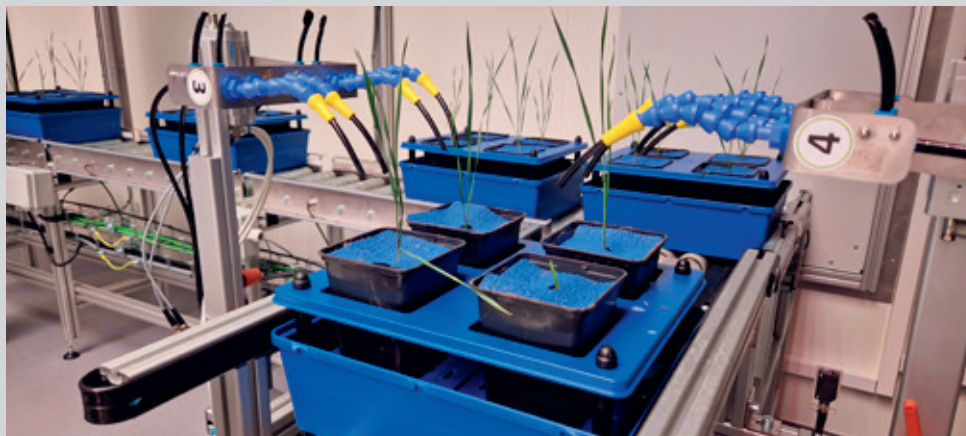
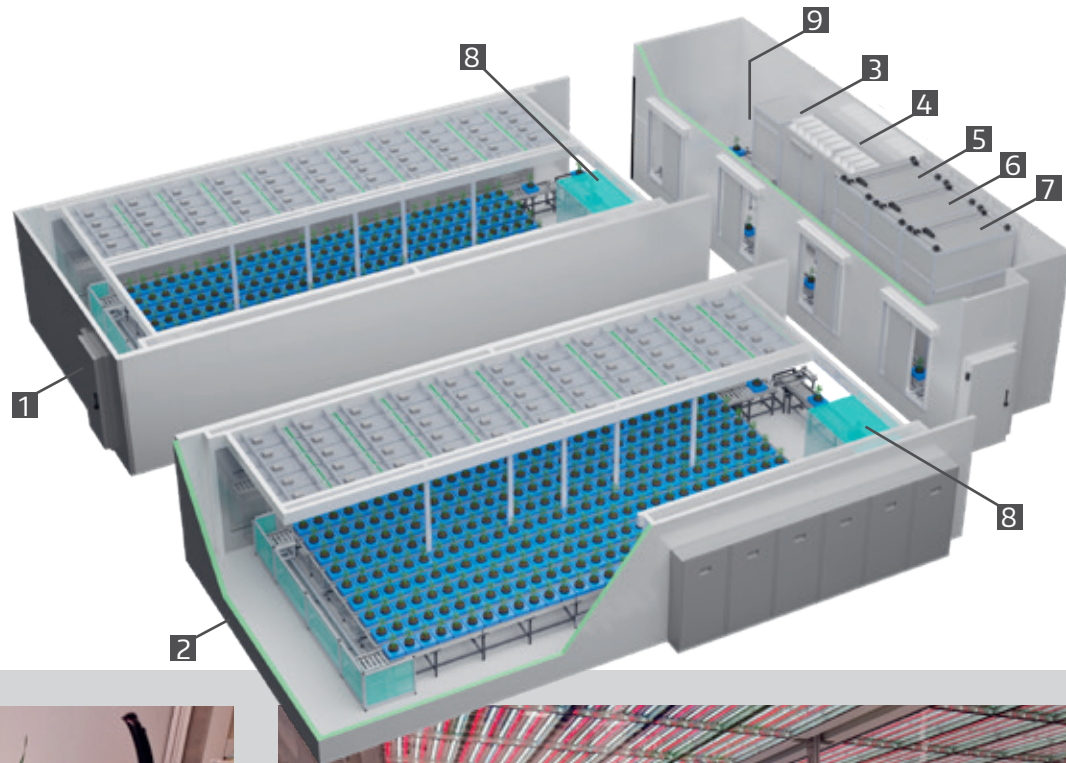


System Specifications

Type of the system	Modular
Capacity of the system	230 trays
Tray types	1x5 l pot / 2x3 l pot / 4x2 l pot / 20x0.25 l pots
Plant size	150x50 cm
Number of lines in growing buffer	2x9
Adaptation chamber illumination	Cool white (Maximum intensity 500 $\mu\text{mol}/\text{m}^2/\text{s}$)
Rating and applications stations	Chlorophyll fluorescence imaging RGB morphometric imaging from top and side view 3D laser scanning VNIR/SWIR hyperspectral imaging 2 x watering and weighing unit
Environmental sensors	Light intensity, temperature and humidity pH, T for watering and weighing units

Layout Schematics

- 1 Cultivation area 1
- 2 Cultivation area 2
- 3 Pre-adaptation area
- 4 Light/dark adaptation tunnel
- 5 Chlorophyll fluorescence imaging
- 6 RGB, 3D laser scanning, Thermal imaging
- 7 Hyperspectral imaging
- 8 Watering & Weighing
- 9 Imaging area



2023

PLANTSCREEN™ MODULAR SYSTEM

CHINA NATIONAL RICE RESEARCH INSTITUTE (CNRI), HANGZHOU, CHINA

PlantScreen™ Modular System with capacity of 300 trays. 1. imaging compartment with all imaging units and **watering and weighing unit**, and 2. large cultivation compartment. Maximum plants size is 180 cm in height and 60 cm in width.

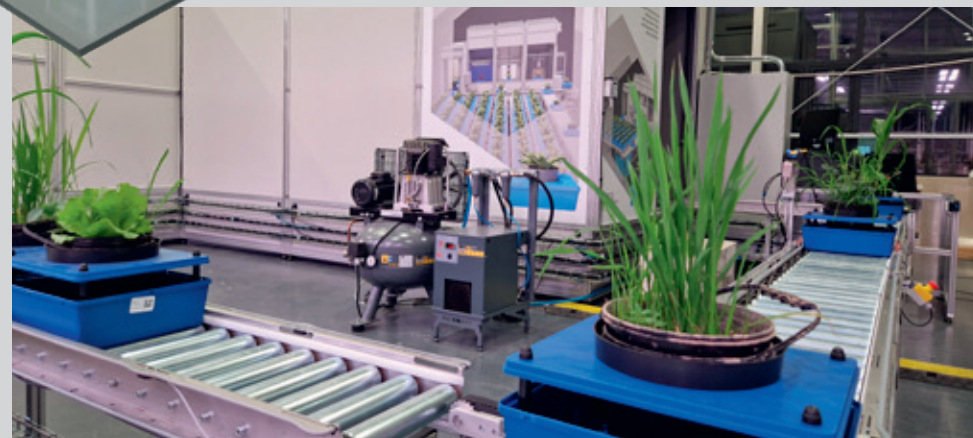
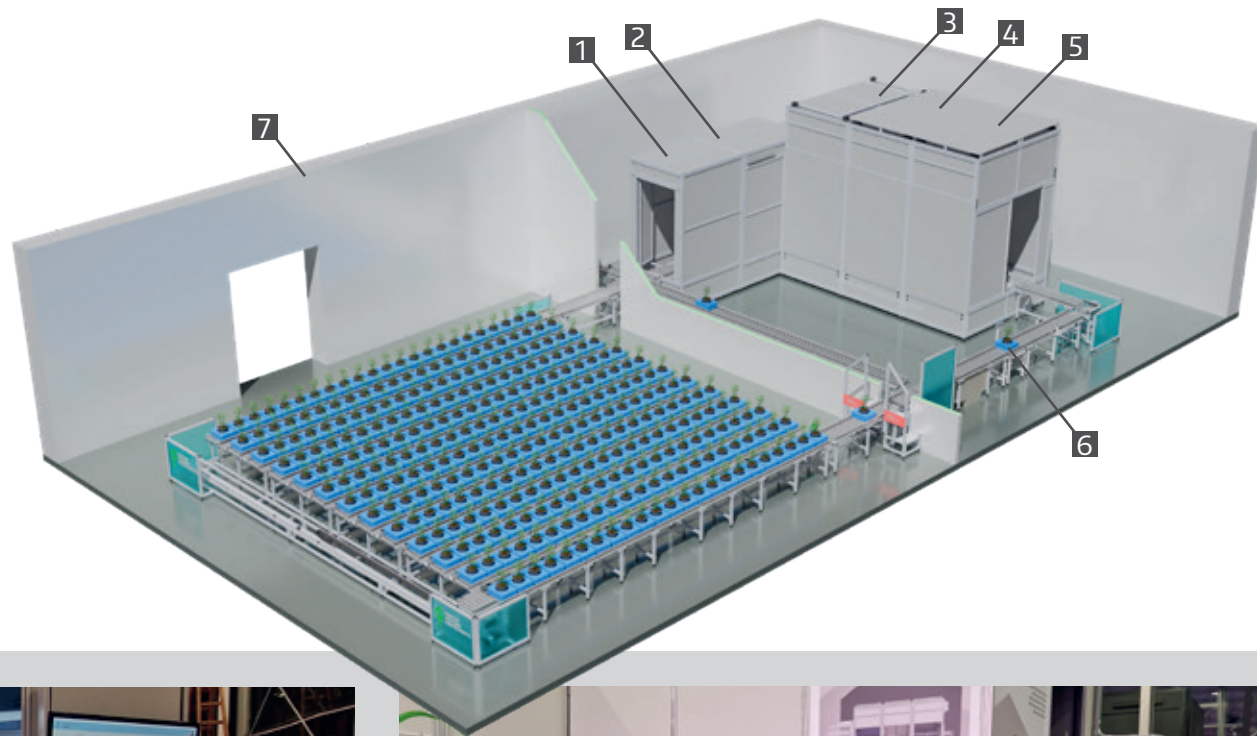


System Specifications

Type of the system	Modular
Capacity of the system	300 trays
Tray types	1x5 l pot / 2x3 l pot / 4x2 l pot
Plant size	180×60 cm
Number of lines in growing buffer	12
Adaptation chamber illumination	Cool white (Maximum intensity 500 $\mu\text{mol}/\text{m}^2/\text{s}$)
Rating and applications stations	Multi-spectral chlorophyll fluorescence Imaging RGB Morphometric imaging from top and side view VNIR/SWIR hyperspectral Imaging Watering and weighing unit
Environmental sensors	Light intensity, temperature and humidity

Layout Schematics

- 1 Light curtain
- 2 Adaptation tunnel
- 3 Chlorophyll fluorescence imaging
- 4 RGB imaging station
- 5 VNIR & SWIR imaging
- 6 Watering & Weighing
- 7 Growing buffer area



2023

PLANTSCREEN™ MODULAR SYSTEM

NORTHEAST INSTITUTE OF GEOGRAPHY AND AGROECOLOGY, CAS CHANGCHUN, CHINA

PlantScreen™ Modular System with capacity of **208 trays** is installed inside of customized growth room. The system includes **imaging loop** with all imaging units and **watering and weighing unit**, and **cultivation area**. Maximum plants size is 100 cm in height and 50 cm in width.

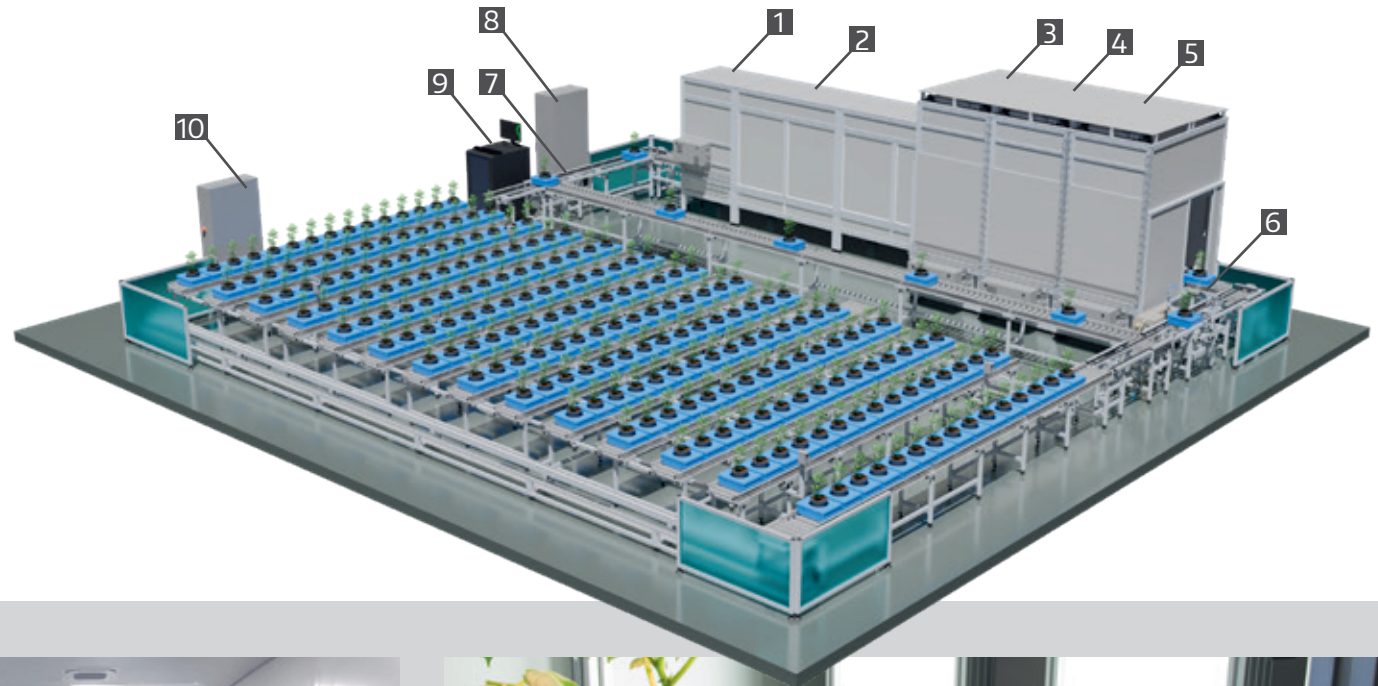


System Specifications

Type of the system	Modular
Capacity of the system	208 trays
Tray types	2×1 (3 l pots), 2×2 pots (2 l pots), 1×1 (5 l pots)
Plant size	100×50 cm
Number of lines in growing buffer	13
Adaptation chamber illumination	Cool white (Maximum intensity 500 $\mu\text{mol}/\text{m}^2/\text{s}$)
Rating and applications stations	Chlorophyll fluorescence imaging RGB morphometric imaging from top and side view 3D laser scanning
Environmental sensors	Light intensity, temperature and humidity

Layout Schematics

- 1 Pre-adaptation area
- 2 Light/dark adaptation tunnel
- 3 Multispectral chlorophyll fluorescence imaging
- 4 RGB imaging, 3D laser scanning
- 5 VNIR/SWIR hyperspectral imaging
- 6 Watering & Weighing
- 7 Loading/unloading area
- 8 Main control cabinet
- 9 PC cabinet with database server
- 10 Buffer control cabinet



2023

PLANTSCREEN™ MODULAR SYSTEM

BIOTECHNOLOGY RESEARCH INSTITUTE, CAAS BEIJING, CHINA

PlantScreen™ Modular System with capacity of **208 trays** is installed inside of customized greenhouse. The system includes **imaging loop** with all imaging units and **watering and weighing unit**, and **cultivation area**. Maximum plants size is 180 cm in height and 100 cm in width.

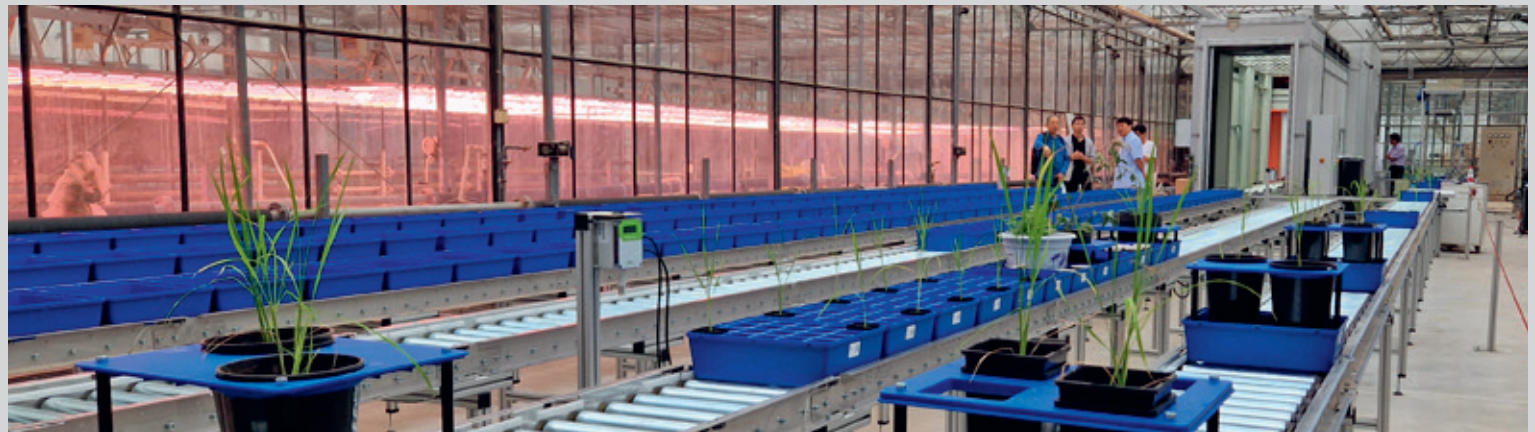
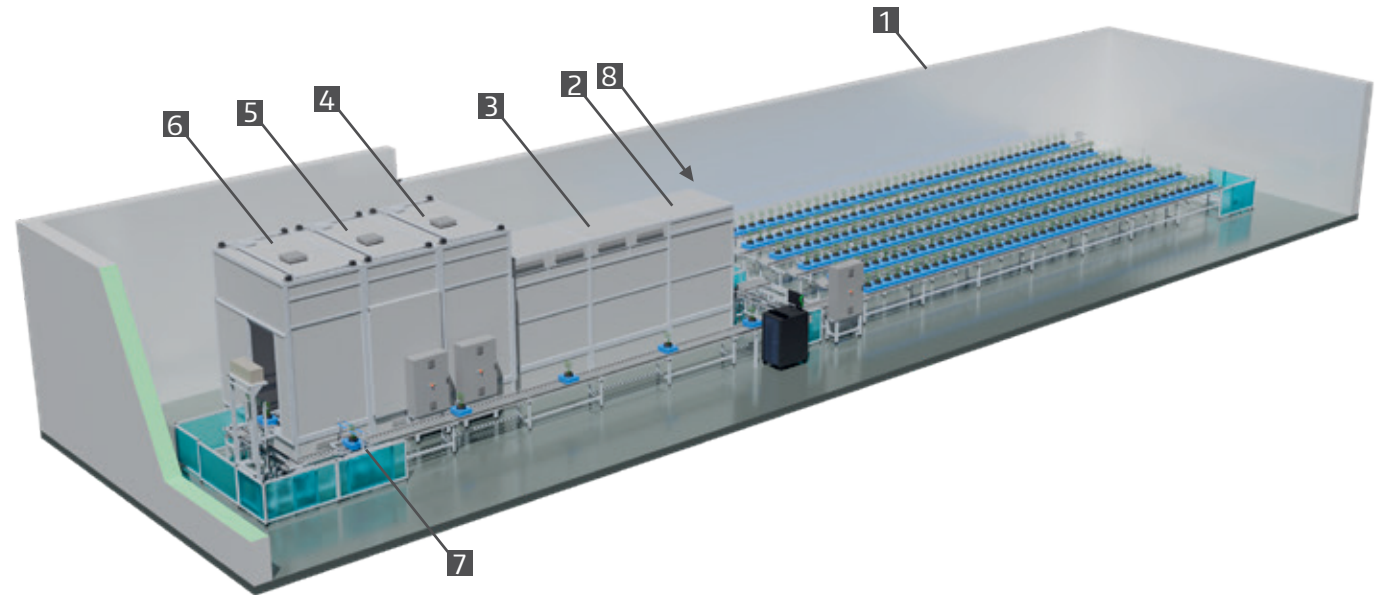


System Specifications

Type of the system	Modular
Capacity of the system	200 trays
Tray types	5×4 pots (250 ml pots), 2×1 (3 l pots), 2×2 pots (2 l pots), 1×1 (5 l pots)
Plant size	180×100 cm
Number of lines in growing buffer	5
Adaptation chamber illumination	Cool white (Maximum intensity 500 $\mu\text{mol}/\text{m}^2/\text{s}$)
Rating and applications stations	Chlorophyll fluorescence imaging, RGB morphometric imaging from top and side view 3D laser scanning, thermal imaging VNIR/SWIR hyperspectral imaging Watering and weighing unit for tray types 2×2, 2×1, 1×1 Watering and weighing unit for tray type 5×4
Environmental sensors	Light intensity, temperature and humidity

Layout Schematics

- 1 Cultivation area
- 2 Pre-adaptation area
- 3 Light/dark adaptation tunnel
- 4 Chlorophyll fluorescence imaging
- 5 RGB, 3D laser scanning, Thermal imaging
- 6 Hyperspectral imaging
- 7 Watering & Weighing
- 8 Loading/unloading area



2023

PLANTSCREEN™ MODULAR SYSTEM IN WALK-IN CHAMBER

NPEC, UTRECHT UNIVERSITY, NETHERLANDS

The system is designed for high-throughput phenotyping of mid-size crop plants with dimensions up to **100×50 cm**. Helios system is fully integrated into a state-of-the-art **walk-in FytoScope chamber** providing highly homogeneous plant growth condition in **two individually controlled compartments**, i.e. cultivation area and imaging area. The Helios system can accommodate a maximum of **1,260 pots** with small size plants as Arabidopsis at full capacity. The imaging sensors include **multispectral chlorophyll fluorescence**, RGB, VNIR/SWIR hyperspectral, thermal and 3D.

Links: <https://www.uu.nl/en/news/fully-automatic-monitoring-of-plant-growth-development-and-disease-progression-with-helios>

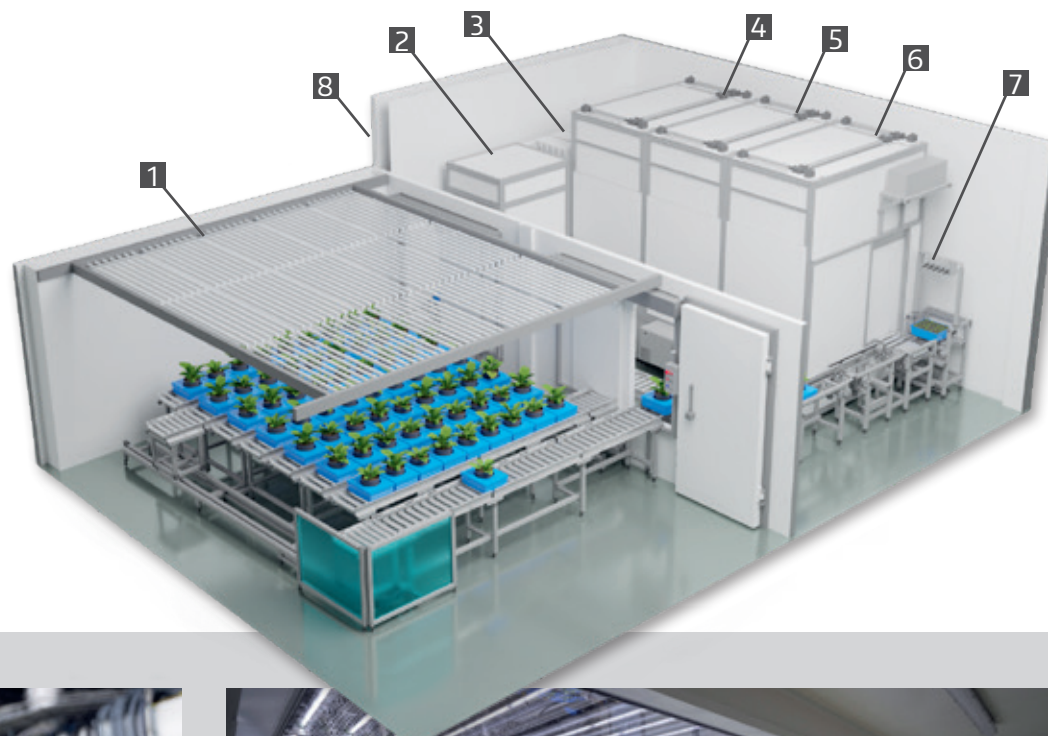


System Specifications

Type of the system	Modular
Capacity of the system	63 trays
Tray types	5×4 pots (250 ml pots), 2×1 (3 l pots), 2×2 pots (2 l pots), 1×1 (5 l pots)
Plant size	100×50 cm
Number of lines in growing buffer	7
Adaptation chamber illumination	Cool white (Maximum intensity 500 $\mu\text{mol}/\text{m}^2/\text{s}$)
Rating and applications stations	Multispectral chlorophyll fluorescence imaging RGB morphometric imaging from top and side view 3D laser scanning Thermal imaging VNIR/SWIR hyperspectral imaging Watering and weighing unit for tray types 2×2, 2×1, 1×1 Watering and weighing unit for tray type 5×4
Environmental sensors	Light intensity, temperature and humidity

Layout Schematics

- 1 Cultivation area
- 2 Pre-adaptation with laser height bar
- 3 Light/dark adaptation tunnel
- 4 Multispectral chlorophyll fluorescence imaging
- 5 Multiangle RGB and 3D laser scanning
- 6 VNIR hyperspectral imaging
- 7 Watering & Weighing
- 8 Imaging area



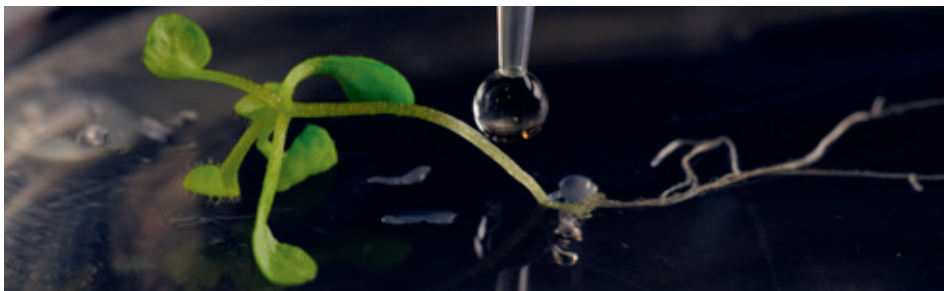
PLANTSCREEN™ AGAR ROOT ROBOTICS SYSTEM IN WALK-IN CHAMBER

NPEC, UTRECHT UNIVERSITY, NETHERLANDS

The system is designed for high-throughput, automated, software-controlled phenotyping of plants grown in vitro. The Hades system is customized for efficient operation with PSI developed square Petri plates, and can accommodate a maximum of 2,160 plates at full capacity. The process initiates with sample preparation and cultivation, encompassing tasks such as media pouring and automated robotic seeding. It progresses through stratification at 5 °C to long-term cultivation of samples in "Growth Hotels". Complete automation through robotic manipulation facilitates the integration of multiple imaging stations for monitoring of root morphology, the detection of expression of various fluorescent proteins in plant roots, and the measurement of chlorophyll fluorescence kinetics in plant shoots. The system also includes fluorescence hyperspectral imaging of coumarins production. The entire system is designed with an emphasis on sterility, and manipulation with GMO plants and bacteria.

Links:

<https://www.npec.nl/news/hades-high-throughput-fluorescence-based-phenotyping-of-in-vitro-root-systems/>

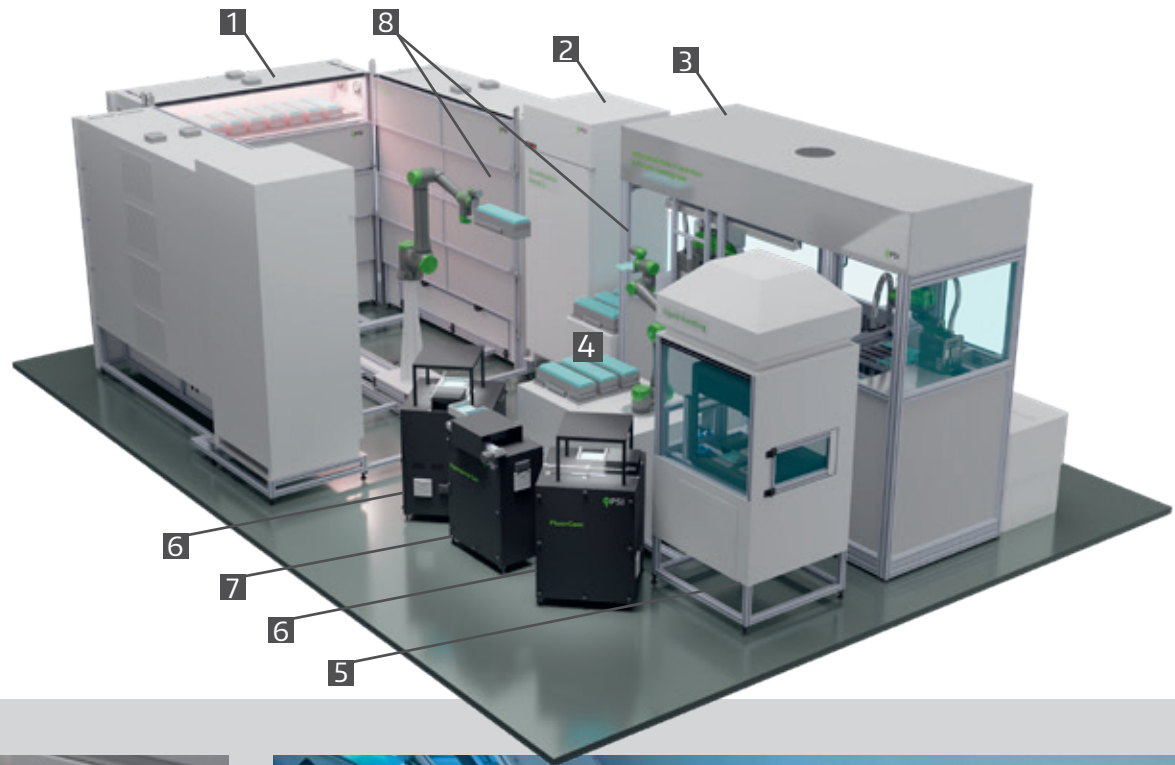


System Specifications

Type of the system	Agar Root Robotics
Capacity of the system	2160 plates
Cultivation chamber illumination	Cool white, Deep red, Far-red (Maximum intensity 400 $\mu\text{mol}/\text{m}^2/\text{s}$)
Rating and applications stations	Multispectral chlorophyll fluorescence imaging RGB morphometric imaging VNIR hyperspectral Imaging
Environmental sensors	Light intensity, temperature and humidity

Layout Schematics

- 1 Growth hotels
- 2 Stratification hotels
- 3 Plate preparation table
- 4 User buffer
- 5 Liquid handling
- 6 Multispectral chlorophyll fluorescence imaging
- 7 VNIR hyperspectral imaging
- 8 Robotic arm



2023

PLANTSCREEN™ XY SYSTEMS IN GROWTH CAPSULES

**AUSTRIAN INSTITUTE OF TECHNOLOGY (AIT),
TULLN, AUSTRIA**

PlantScreen™ XY System for plants up to 65 cm in height is installed inside of Growth capsule (GC) DUAL large-scale cultivation unit with imaging area of 1000x3300 mm. Each GC DUAL consists of two independently controlled segments with the main access and operational zone in the middle. Each unit integrates **PlantScreen™ XY System**. Robotic imaging modules that can be **modularly exchanged** include **PAM chlorophyll fluorescence imaging plus multi-color imaging unit**, **RGB morphometric imaging**, **VNIR and SWIR hyperspectral imaging** and **3D laser scanning unit**.

Links:

<https://www.ait.ac.at/en/research-topics/bioresources/phenotyping-of-plants>

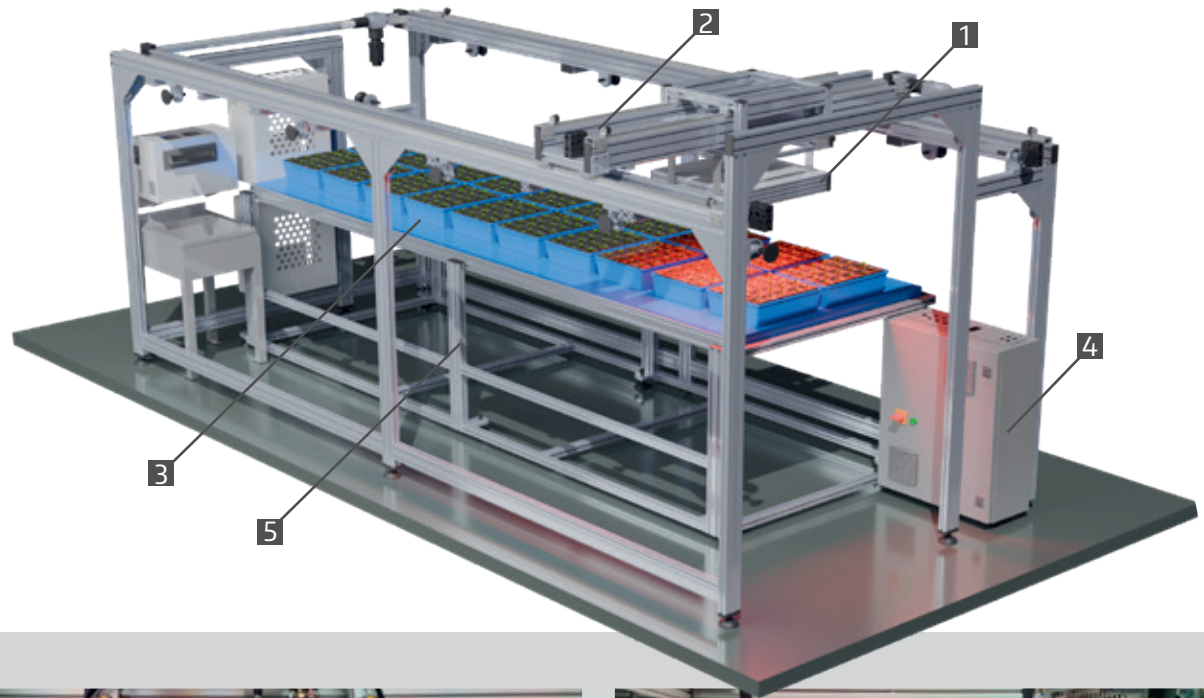


System Specifications

Type of the system	XY
Imaging area of the system	1000x3300 mm
XY axis range	X: 790 mm Y: 3325 mm
Plant size	65x20 cm
Rating and applications stations	Chlorophyll fluorescence imaging RGB morphometric imaging VNIR hyperspectral imaging 3D laser scanner
Environmental sensors	Light intensity, CO ₂ , temperature and humidity

Layout Schematics

- 1 Imaging module for chlorophyll fluorescence, VNIR, RGB and 3D laser scanner imaging sensors
- 2 XY moving robotic arm
- 3 Cultivation / imaging area
- 4 Control cabinet
- 5 Height-adjustable cultivation table



2023

PLANTSCREEN™ MODULAR SYSTEM IN WALK-IN CHAMBER

**NATIONAL INSTITUTE OF BIOLOGY (NIB),
LJUBJANA, SLOVENIA**

The system is designed for small-scale fully automated phenotyping of mid-size crop plants with dimensions up to **70×40 cm**. The system is fully integrated into a state-of-the-art **walk-in PhytoScope chamber** providing highly homogeneous plant growth condition. The system includes **imaging loop** with all imaging units including **multispectral chlorophyll fluorescence imaging**, **RGB morphometric imaging**, **SWIR hyperspectral**, thermal and 3D.



NIB NACIONALNI INŠTITUT ZA BIOLOGIJO
NATIONAL INSTITUTE OF BIOLOGY



System Specifications

Type of the system	SC
Capacity of the system	5 trays
Tray types	5×4 (250 ml pots), 2×2 (2 l pots), 1×1 (5 l pots)
Plant size	70×40 cm
Rating and applications stations	Multispectral chlorophyll fluorescence imaging RGB morphometric imaging from top and side view 3D laser scanning Thermal imaging SWIR hyperspectral imaging
Environmental sensors	Light intensity, temperature and humidity

Layout Schematics

- 1** Imaging box 1 - multispectral chlorophyll fluorescence imaging, RGB morphometric imaging, thermal imaging, 3D laser scanning
- 2** Imaging box 2 - SWIR hyperspectral imaging, RGBS camera
- 3** Control cabinet
- 4** Secondary control panel
- 5** Control PC with database server
- 6** Loading/unloading position
- 7** QR code reader



PLANTSCREEN™ SC MODULAR SYSTEM

BIOSENSE INSTITUTE, NOVI SAD, SERBIA

The system is designed for small-scale fully automated phenotyping of mid-size crop plants with dimensions up to **120×50 cm**. The system includes **imaging loop** with all imaging units including **multispectral chlorophyll fluorescence imaging**, **RGB imaging**, **SWIR hyperspectral**, **thermal** and **3D**.

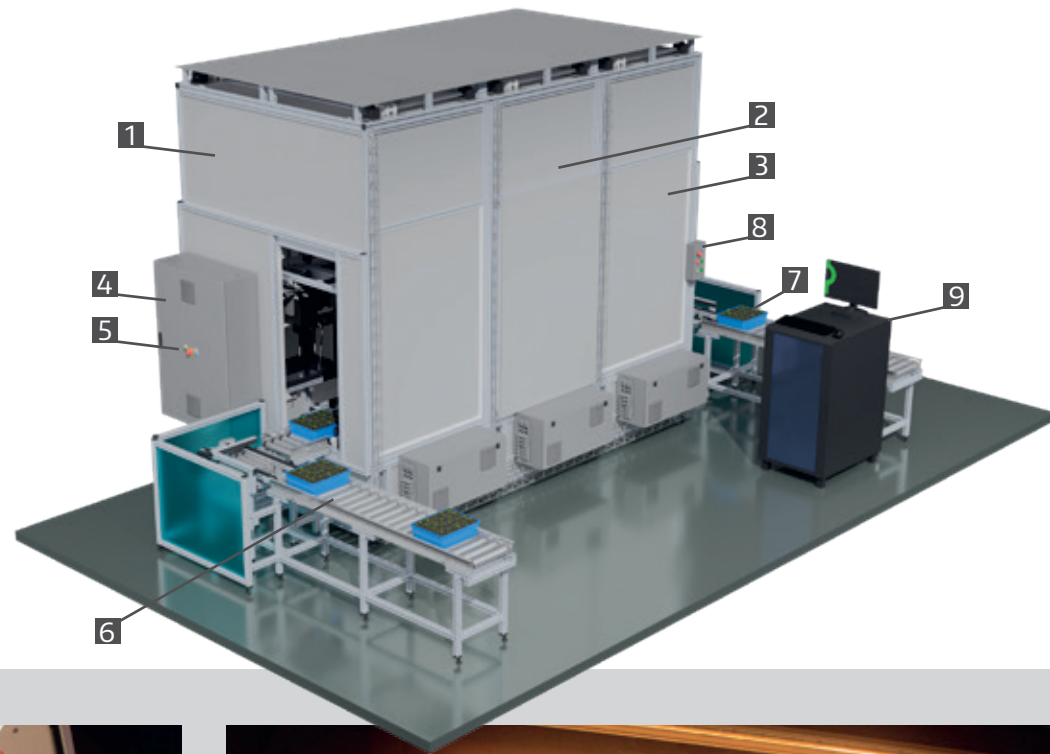


System Specifications

Type of the system	SC
Capacity of the system	5 trays
Tray types	5×4 (250 ml pots), 2×2 (2 l pots), 1×1 (5 l pots)
Plant size	120×50 cm
Rating and applications stations	Multispectral chlorophyll fluorescence imaging RGB morphometric imaging from top and side view 3D laser scanning Thermal imaging VNIR/SWIR hyperspectral imaging
Environmental sensors	Light intensity, temperature and humidity

Layout Schematics

- 1 Hyperspectral imaging, VNIR/SWIR
- 2 3D laser, RGB and thermal imaging
- 3 Chlorophyll fluorescence imaging
- 4 Main control cabinet
- 5 Main control panel
- 6 Unloading area
- 7 Loading area
- 8 Secondary control panel
- 9 PC cabinet with database server



2022

PLANTSCREEN™ SC SYSTEM

ITQB NOVA, UNIVERSITY OF LISBOA, PORTUGAL

The PlantScreen™ SC System is designed small scale fully automated phenotyping of plants up to 120 cm in height and 50 cm in width with potential future extension to Modular System. The system includes three light-insulated imaging cabinets for chlorophyll fluorescence imaging, RGB top and side multi-angle imaging, VNIR hyperspectral imaging.

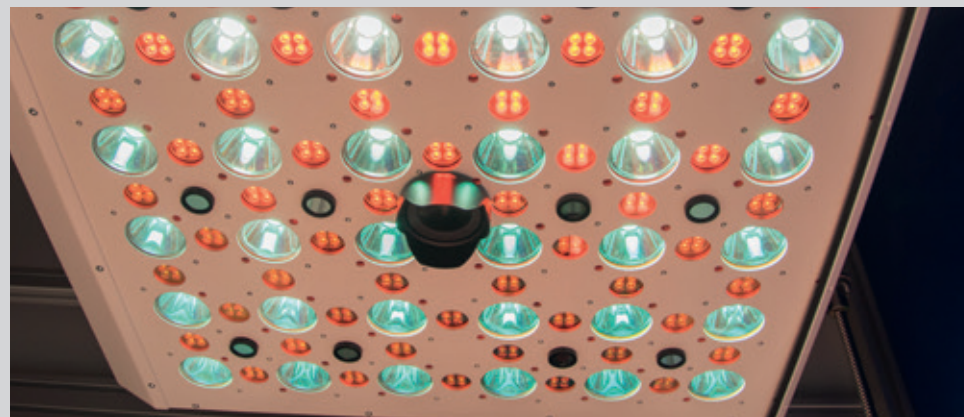
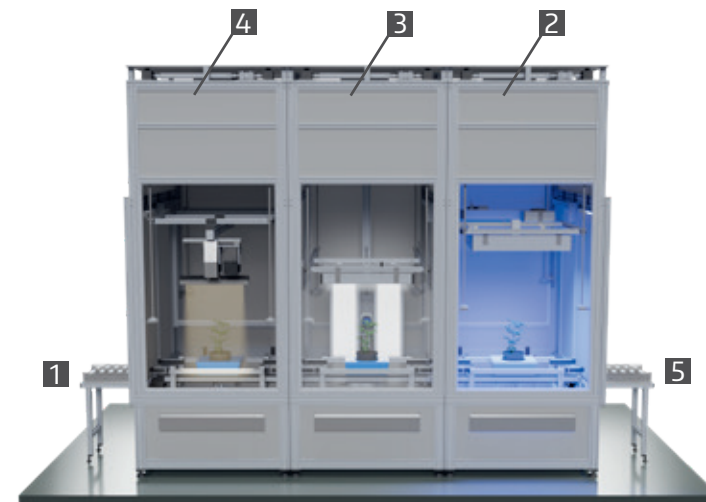
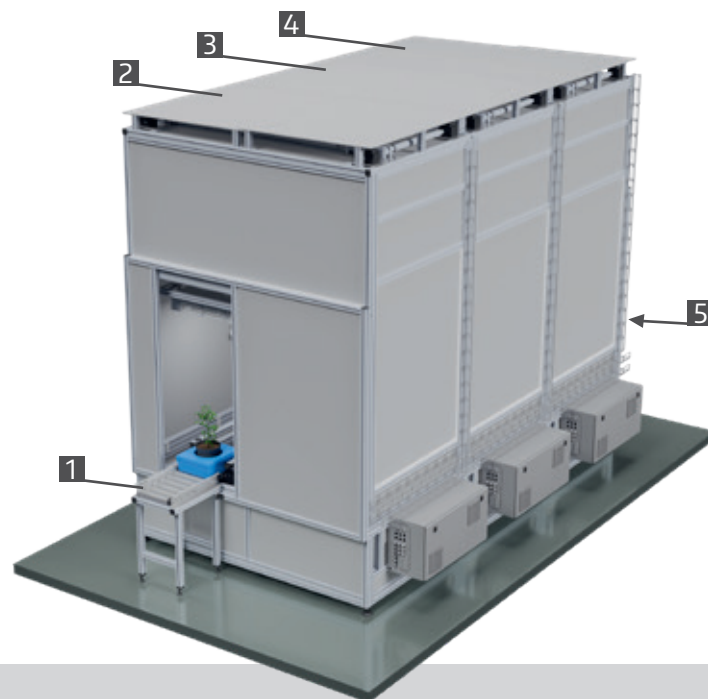


System Specifications

Type of the system	SC
Capacity of the system	5 trays
Tray types	5×4 (250 ml pots), 2×2 (2 l pots), 1×1 (5 l pots)
Plant size	120×50 cm
Rating and applications stations	Chlorophyll fluorescence imaging RGB morphometric imaging from top and side view VNIR hyperspectral imaging
Environmental sensors	Light intensity, temperature and humidity

Layout Schematics

- 1 Loading area
- 2 Chlorophyll fluorescence imaging
- 3 RGB imaging
- 4 VNIR imaging
- 5 Unloading area



2022

PLANTSCREEN™ MODULAR SYSTEM

DEPARTMENT OF BIOLOGY, UNIVERSITY OF SHERBROOKE, CANADA

The system is optimized for high-throughput phenotyping of small up to mid-size crop plants with dimensions up to **100×50 cm**. The system consists of two integrated units, i.e. cultivation area with growing buffer integrated inside of greenhouse environment and imaging area with imaging units and watering and weighing stations. The imaging sensors include **chlorophyll fluorescence**, **RGB**, **VNIR/SWIR hyperspectral** and **3D imaging sensors**.

Links:

<https://www.usherbrooke.ca/biologie/actualites/nouvelles/details/50581>

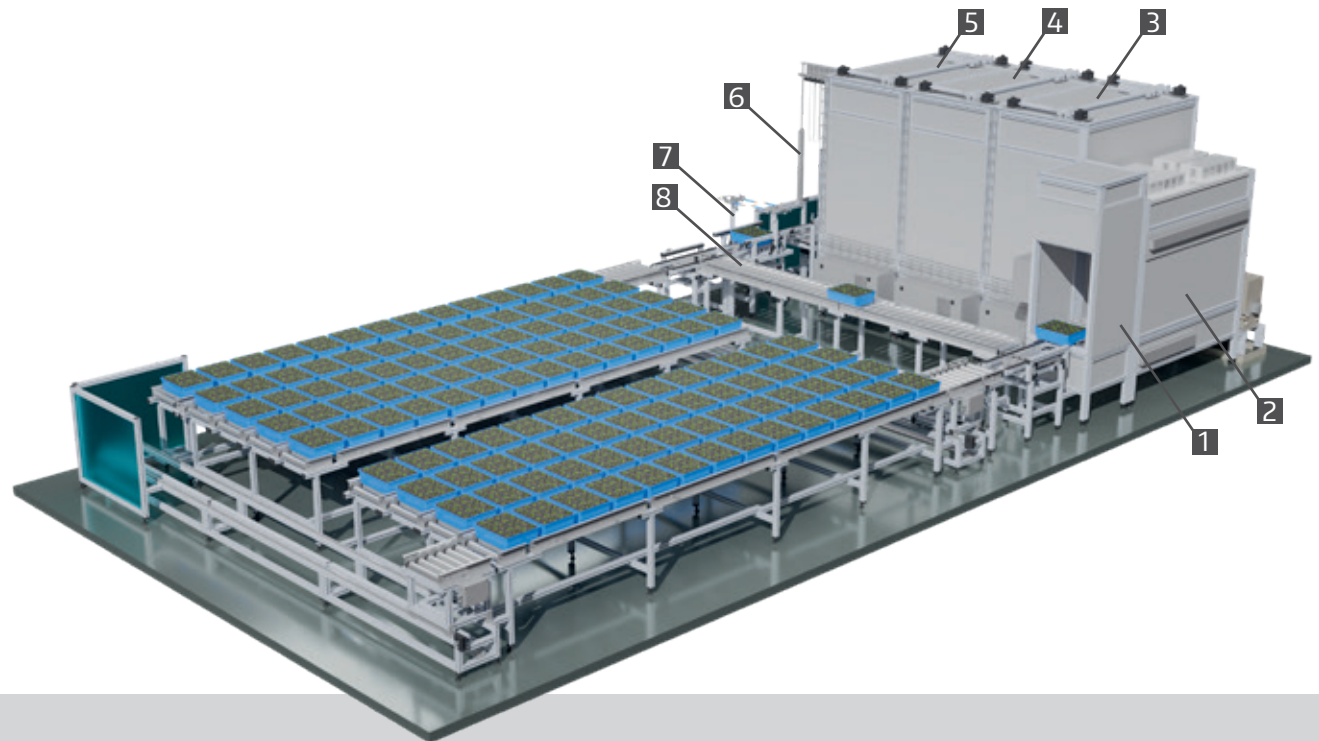


System Specifications

Type of the system	Modular
Capacity of the system	110 trays
Tray types	5×4 pots (250 ml pots), 2×1 (3 l pots) 2×2 pots (2 l pots), 1×1 (5 l pots)
Plant size	100×50 cm
Number of lines in growing buffer	8
Adaptation chamber illumination	Cool white (Maximum intensity 500 $\mu\text{mol}/\text{m}^2/\text{s}$)
Rating and applications stations	Chlorophyll fluorescence imaging RGB morphometric imaging from top and side view 3D laser scanning VNIR/SWIR hyperspectral imaging Watering and weighing unit for tray types 2x2, 2x1, 1x1 with 2 watering tanks, Watering and weighing unit for tray type 5 x 4 with 2 watering tanks
Environmental sensors	Light intensity, temperature and humidity pH for watering tanks

Layout Schematics

- 1 Light barrier
- 2 Adaptation LED lights
- 3 Chlorophyll fluorescence imaging
- 4 3D laser, RGB imaging
- 5 VNIR/SWIR
- 6 Watering & Weighing - 5 pots
- 7 Watering & Weighing - 1 or 4 pots
- 8 Imaging loop



2022

PLANTSCREEN™ SC MINI SYSTEM

UNIVERSITÀ CATTOLICA DEL SACRO CUORE, PIACENZA, ITALY

The system is designed for small-scale automated phenotyping of mid-size crop plants with dimensions up to **80×40 cm** that are manually loaded. The system includes **chlorophyll fluorescence** and **RGB** imaging unit from top view.

References:

SECOMANDI E., DE GREGORIO M. A., CASTRO-CEGRÍA, ET AL. (2024). *Single and combined effect of salinity, heat, cold, and drought in Arabidopsis at metabolomics and photosynthetic levels.* bioRxiv 2024.06.23.600276.

DOI: 10.1101/2024.06.23.600276



UNIVERSITÀ
CATTOLICA
del Sacro Cuore

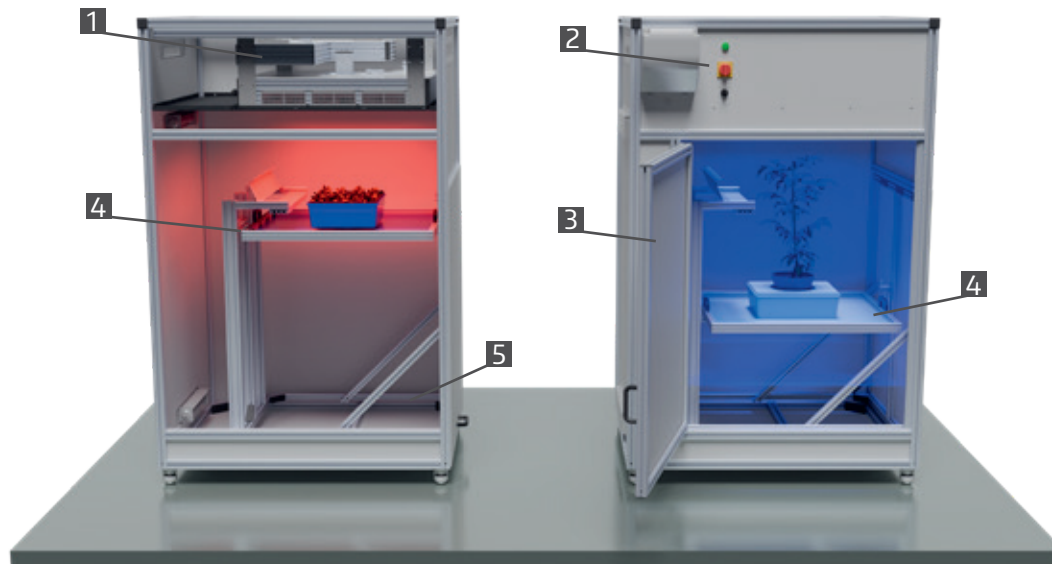


System Specifications

Type of the system	SC Mini
Capacity of the system	1 tray
Tray types	5×4 (250 ml pots), 2×2 (2 l pots), 1×1 (5 l pots)
Plant size	80×40 cm
Rating and applications stations	Chlorophyll fluorescence imaging RGB morphometric imaging from top view
Environmental sensors	Temperature and humidity

Layout Schematics

- 1 Chlorophyll fluorescence imaging & RGB camera
- 2 Control panel
- 3 Manipulation door
- 4 Positioning shelf
- 5 Manipulation drawer



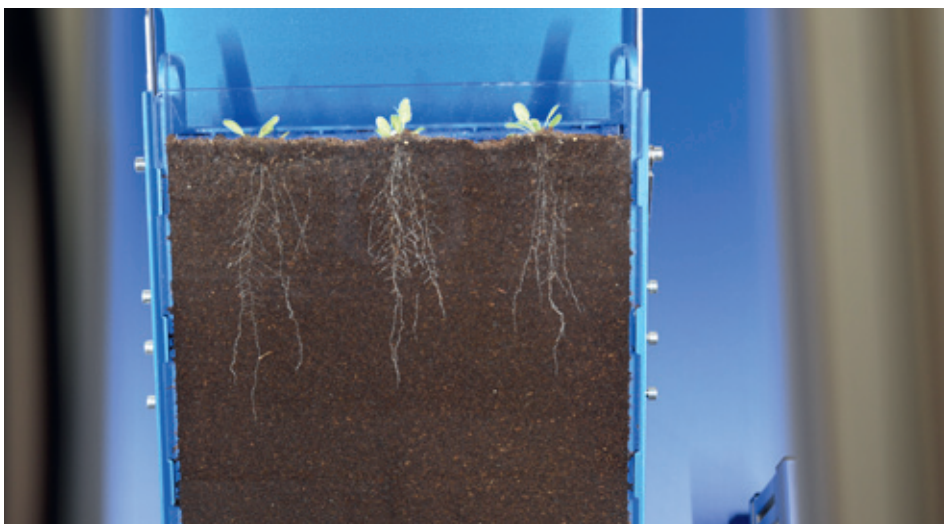
PLANTSCREEN™ SC ROOT SYSTEM

UNIVERSITY OF PICARDIE JULES VERNE, CRRBM, AMIENS, FRANCE

The **PLANTSCREEN™ SC Root System** is customized solution for small-scale fully automated simultaneous root and shoot phenotyping of mid-size crop plants with dimensions up to **60×40 cm**. The system includes **top, side and root specific RGB** imaging unit and is optimized for **Rhizobox** specific root cultivation and simultaneous root and shoot imaging.

Link:

<https://welcome.u-picardie.fr/research/equipment-platforms/equipment-platforms-632587.kjsp>

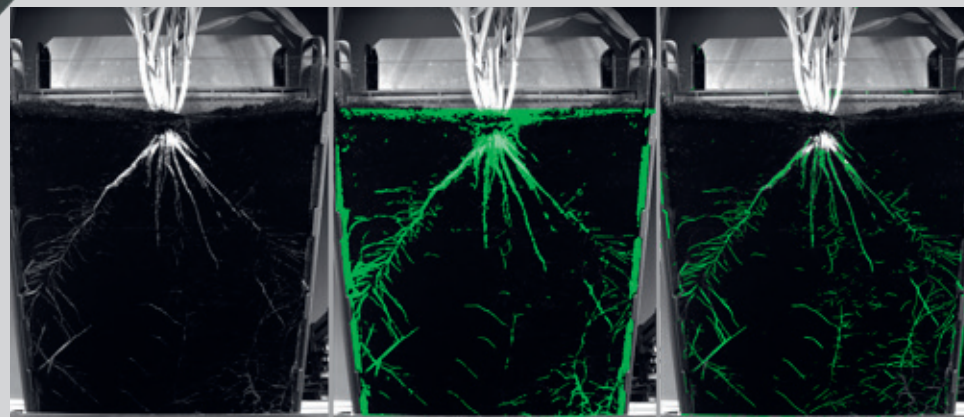
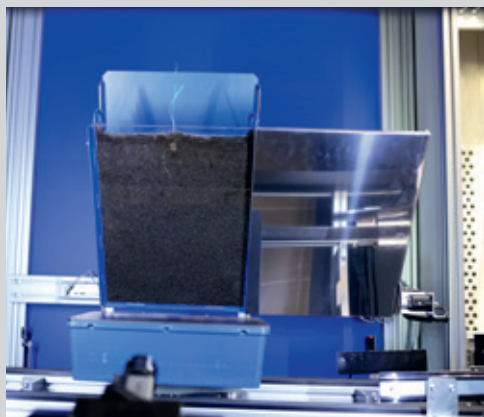
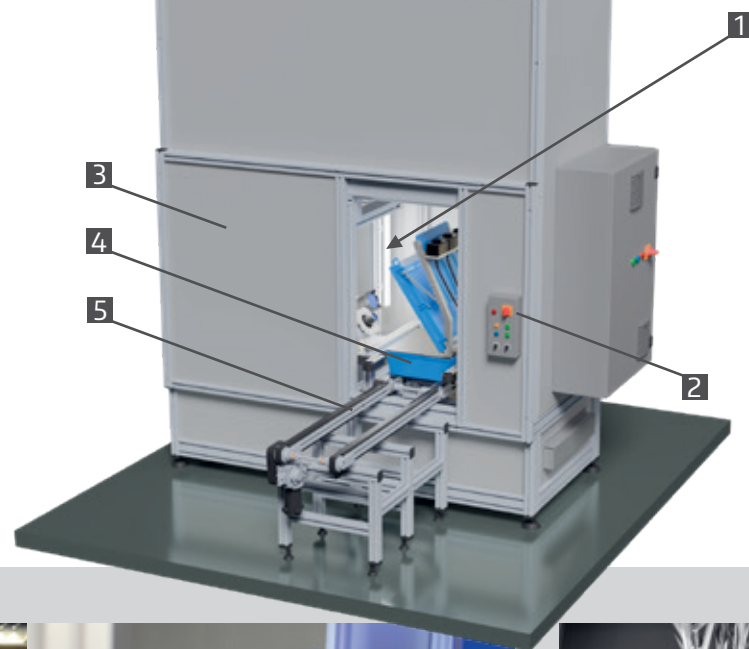


System Specifications

Type of the system	SC Root
Capacity of the system	1 tray
Tray types	Rhizobox, 5×4 (250 ml pots)
Plant size	60×40 cm
Rating and applications stations	RGB morphometric imaging from top and side view Root imaging
Environmental sensors	Temperature and humidity

Layout Schematics

- 1 Chlorophyll fluorescence imaging & RGB camera
- 2 Control panel
- 3 Manipulation door
- 4 Positioning shelf
- 5 Manipulation drawer



2022

HIGH-THROUGHPUT PHENOTYPING WALK-IN CHAMBERS

NPEC, WAHENINGEN UNIVERSITY, NETHERLANDS

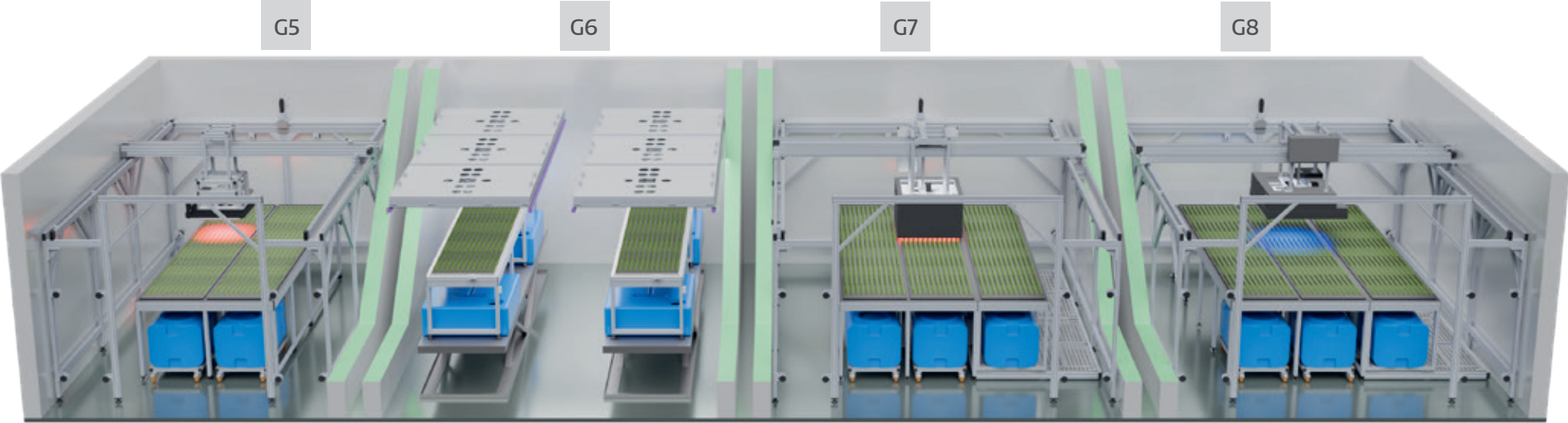
Five high-throughput phenotyping growth rooms with precisely controlled environmental parameters were built inside of dedicated NPEC building in Waheningen campus. Three chambers are of ca. 20 m² and two of ca. 15 m², providing capacity for 300 up to 2200 plants that can be phenotyped using a range of state-of-the-art technologies.

Range of parameters describing plant status, growth and performance can be monitored under a large range of homogeneously controlled environmental conditions.





Layout Schematics



PLANTSCREEN™ XYZ SYSTEMS IN WALK-IN CHAMBER

NPEC, WAGENINGEN UNIVERSITY, NETHERLANDS

PlantScreen™ XYZ System for plants up to **45 cm in height** is installed inside of **large-scale cultivation chamber** (FS-WI, PSI) with imaging area of 2520x3600 mm. The plants are grown hydroponically in individual rock-wool blocks in automatically controlled hydroponic tables. Robotic imaging module includes **PAM chlorophyll fluorescence plus multi-color imaging unit** and **RGB morphometric imaging**. Control of the phenotyping system is fully synchronized with the environmental control of the cultivation chamber. Plethora of environmental sensors is integrated.

Link:

<https://www.npec.nl/tool/five-htp-growth-rooms/>

References:

SURADO-RUIZ, F., NGUYEN, TP., PELLER, J. ET AL. (2024).

DOI: 10.1186/s13007-024-01138-x

THEEUWEN, T.P.J.M., LAWSON A. W., TIJINK W., ET AL. (2022).

DOI: 10.1101/2022.11.13.516254

THEEUWEN, T.P.J.M., LOGIE L. L., PUTS., ET AL. (2022).

DOI: 10.1101/2022.11.13.516256

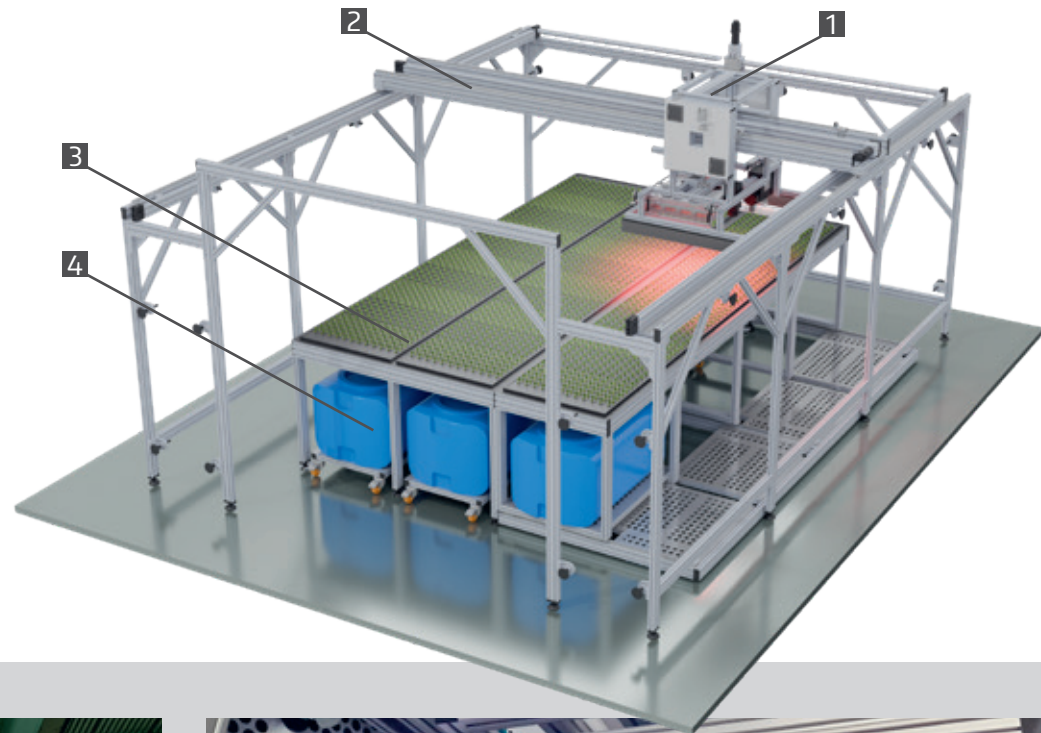


System Specifications

Type of the system	XYZ
Imaging area of the system	2520x3600 mm
XY axis range	X: 4840 mm Y: 3830 Z: 461
Plant size	45x40 cm
Rating and applications stations	Multispectral chlorophyll fluorescence imaging RGB morphometric imaging
Environmental sensors	Light intensity, light spectra, temperature and humidity pH and EC for hydroponic tables

Layout Schematics

- 1 Imaging module for chlorophyll fluorescence imaging & RGB imaging sensors
- 2 XYZ moving robotic arm
- 3 Automatic hydroponic tables
- 4 Nutrient tanks



PLANTSCREEN™ XYZ SYSTEMS IN WALK-IN CHAMBER

NPEC, WAHENINGEN UNIVERSITY, NETHERLANDS

PlantScreen™ XYZ System for plants up to 45 cm in height is installed inside of large-scale cultivation chamber with imaging area of 2520x3600 mm. The plants are grown hydroponically in individual rock-wool blocks in automatically controlled hydroponic tables. Robotic imaging module includes **PAM chlorophyll fluorescence plus multi-color imaging unit, thermal imaging, SWIR hyperspectral imaging** and RGB Morphometric imaging. Control of the phenotyping system is fully synchronized with the environmental control of the cultivation chamber. Plethora of environmental sensors is integrated.

Link:

<https://www.npec.nl/tool/five-htp-growth-rooms/>

References:

SURADO-RUIZ, F., NGUYEN, TP., PELLER, J. ET AL. (2024). LeTra: a leaf tracking workflow based on convolutional neural networks and intersection over union. *Plant Methods* 20, 11.

DOI: 10.1186/s13007-024-01138-x

THEEUWEN, T.P.J.M., LAWSON A. W., TIJINK W., ET AL. (2022). The NDH complex reveals a trade-off that constrains maximising photosynthesis in *Arabidopsis thaliana*. *bioRxiv* 2022.11.13.516254;

DOI: 10.1101/2022.11.13.516254

THEEUWEN, T.P.J.M., LOGIE L. L., PUTS, ET AL. (2022). Plethora of QTLs found in *Arabidopsis thaliana* reveals complexity of genetic variation for photosynthesis in dynamic light conditions. *bioRxiv* 2022.11.13.516256;

DOI: 10.1101/2022.11.13.516256

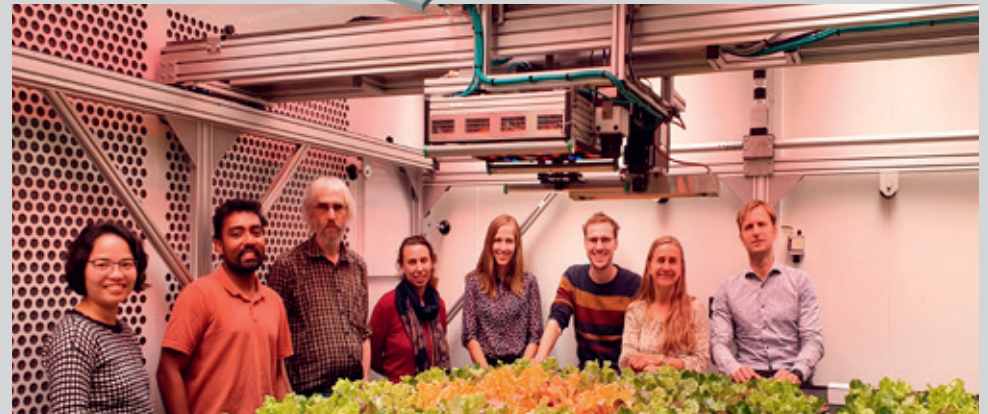
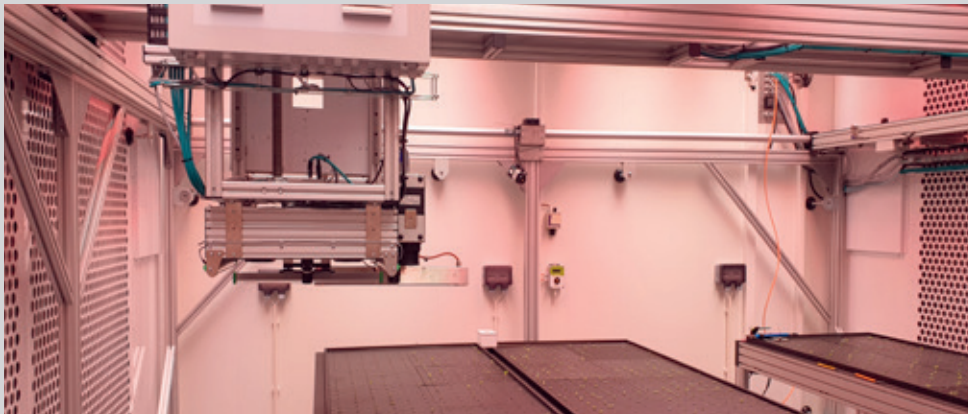
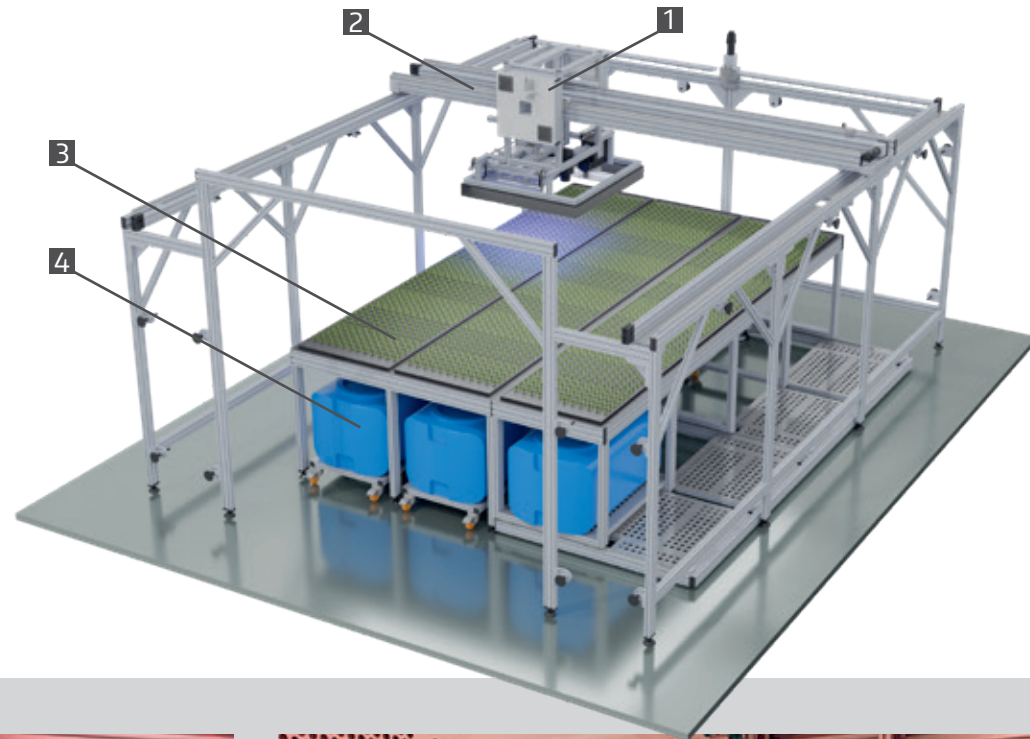


System Specifications

Type of the system	XYZ
Imaging area of the system	2520x3600 mm
XY axis range	X: 4840 mm Y: 3830 Z: 461
Plant size	45x20 cm
Rating and applications stations	Multispectral chlorophyll fluorescence imaging RGB morphometric imaging Thermal imaging SWIR hyperspectral camera with RGB
Environmental sensors	Light intensity, light spectra, CO ₂ , temperature and humidity pH and EC for hydroponic tables

Layout Schematics

- 1 Imaging module for chlorophyll fluorescence & RGB imaging sensors
- 2 XYZ moving robotic arm
- 3 Automatic hydroponic tables
- 4 Nutrient tanks



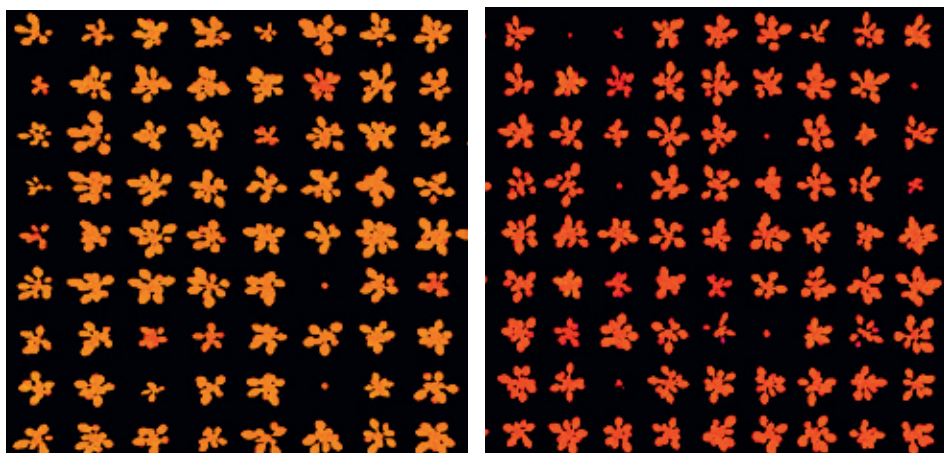
PLANTSCREEN™ MULTICAM SYSTEMS IN WALK-IN CHAMBER

NPEC, WAHENINGEN UNIVERSITY, NETHERLANDS

PlantScreen™ MultiCam Dynamic Light System for plants up to 45 cm in height with hydroponic cultivation is built inside a growth chamber with controlled light, temperature and humidity condition. The plants are grown hydroponically in individual rock-wool blocks in **automatically controlled height-adjustable hydroponic tables**. Stationary fixed MultiCam Dynamic Light system with advanced LED lighting and phenotyping system integrated into the room ceiling allows simultaneous image acquisition, data processing and visualization of the data (i.e. image data, numeric data, false-color scaled fluorescence images) over the entire cultivation area. Up to 1296 plants can be imaged simultaneously with 20 fps resolution.

Link:

<https://www.npec.nl/tool/five-htp-growth-rooms/>

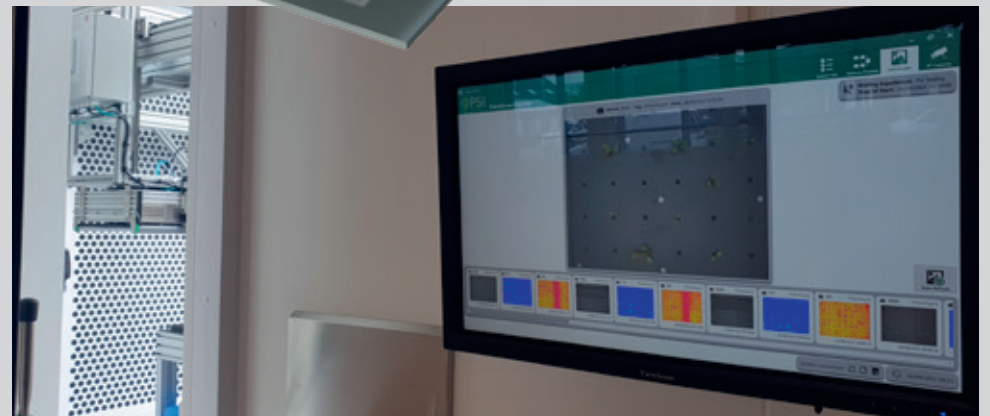
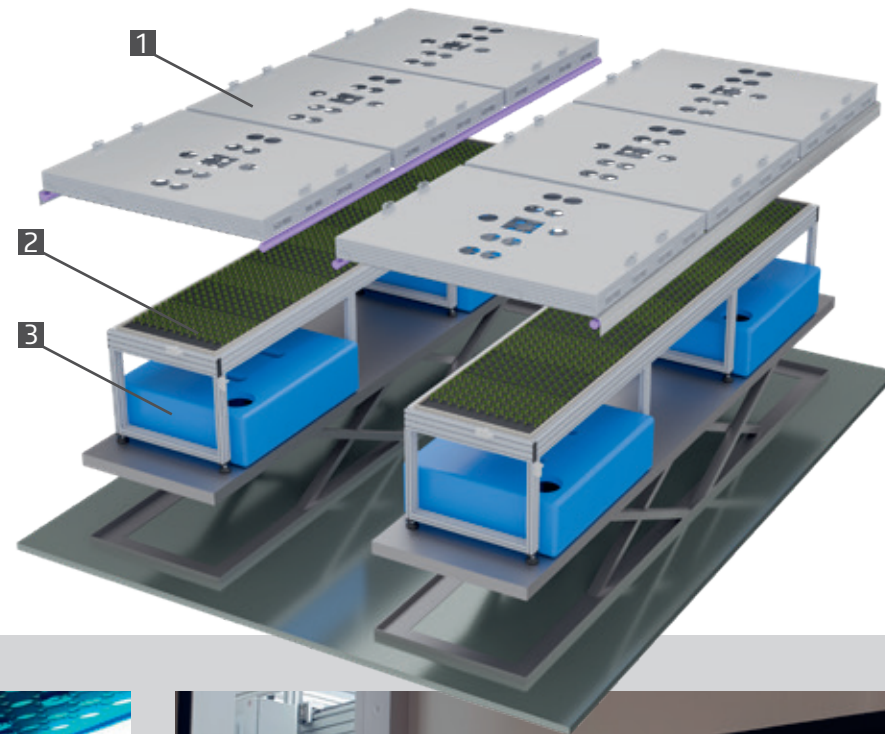


System Specifications

Type of the system	MultiCam Dynamic Light
Imaging area of the system	2x (720x3600 mm)
Plant size	45x40 cm
Rating and applications stations	Multispectral chlorophyll fluorescence imaging
Environmental sensors	Light intensity, light spectra, CO ₂ , temperature and humidity pH and EC for hydroponic tables

Layout Schematics

- 1 Ceiling integrated MultiCam dynamic light system
- 2 Height-adjustable hydroponic tables
- 3 Watering/nutrient tanks



2022

PLANTSCREEN™ ALGAESCREEN ROBOTICS SYSTEM

UNIVERSITY OF TECHNOLOGY SYDNEY, AUSTRALIA

PlantScreen™ AlgaeScreen Robotics System is designed for automated, software-operated algae phenotyping high-throughput manner. The automated algae phenotyping system is designed for microwell plates and maximum capacity of this system is 48 plates in 8 shelves placed in 2 cultivation hotels. The phenotyping system automatically manages whole process of Algae cultivation from sample preparation in liquid handling station to precisely controlled cultivation in Algae hotels. During the cultivation algae are automatically phenotyped in imaging units measuring various chlorophyll fluorescence signals and hyperspectral images in absorbance mode.

Link:

'Super algae' to save the planet | University of Technology Sydney (uts.edu.au)

UTS creates algae-analysing robot to combat climate change - The Robot Report

World Oceans Day: Robot searches for super algae to fight climate change - YouTube



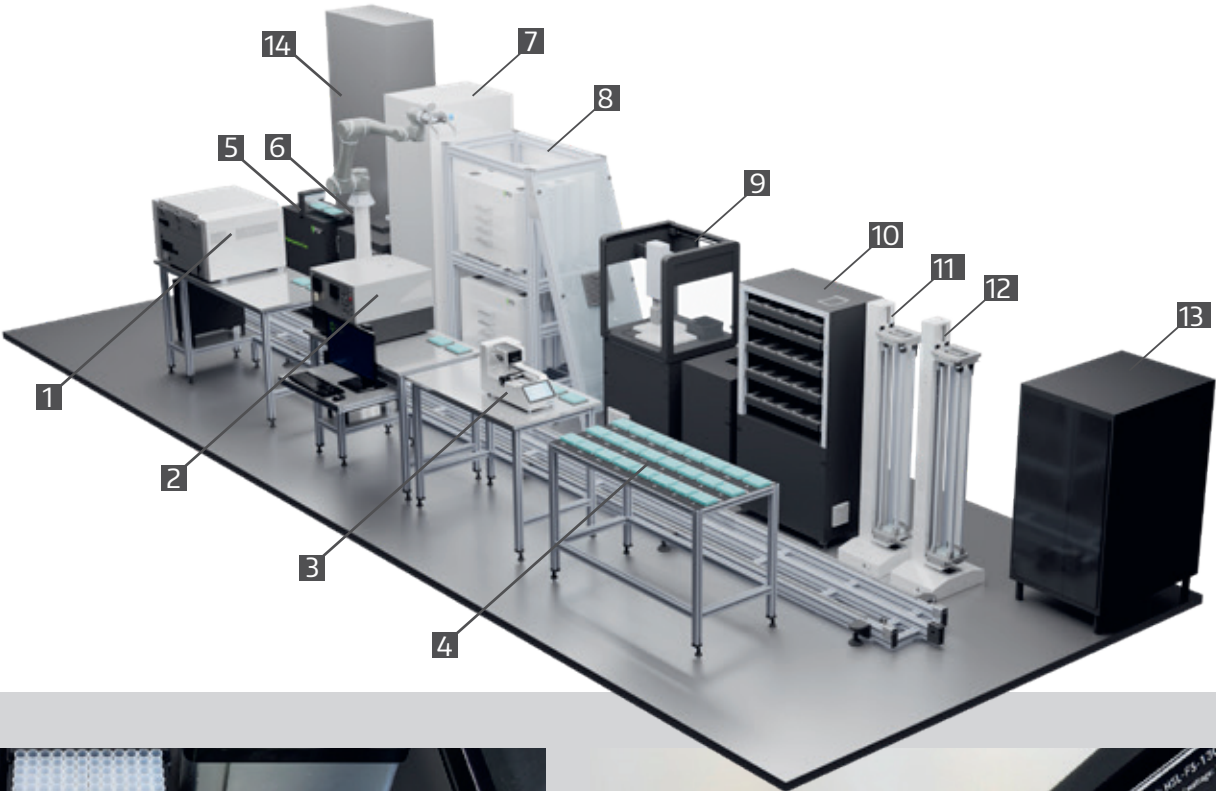
System Specifications

Type of the system	AlgaeScreen Robotics
Capacity of the system	48 plates
Tray types	Microwell plates (Porvair 24 well/ Porvair 96 well)
Number of cultivation hotels	2
Number of shelves in each hotel	4
Number of plates in shelf	6
Rating and applications stations	Fluorescence imaging station VNIR hyperspectral imaging Liquid handling unit

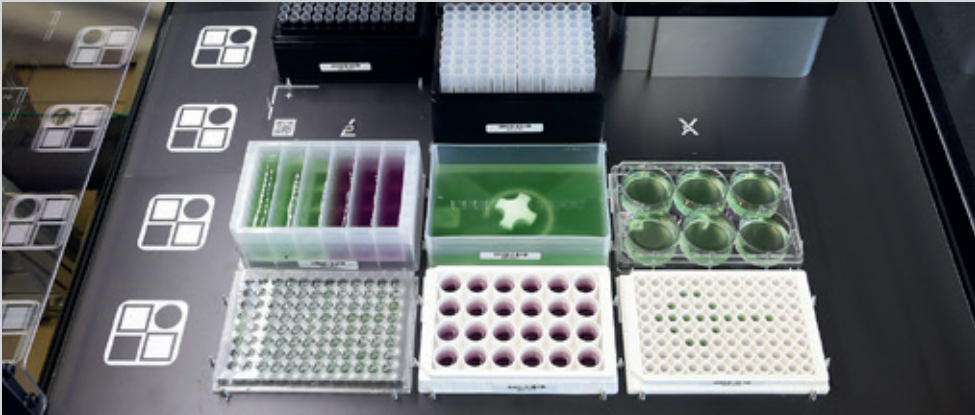


Layout Schematics

- 1 Cytoflex
- 2 Plate reader
- 3 Dispensor
- 4 Storage new
- 5 Hyperspectral imaging
- 6 FlourCam imaging
- 7 Cooling unit
- 8 Algae hotel
- 9 LiquidHandling



- 10 Storage (old)
- 11 Stacker 1
- 12 Stacker 2
- 13 PC Rack
- 14 Control Cabinet



PLANTSCREEN™ XY SYSTEM

THE AUSTRALIA NATIONAL UNIVERSITY (ANU), CANBERRA, AUSTRALIA

PlantScreen™ XY System for plants up to 65 cm in height is installed inside of Growth capsule (GC) DUAL large-scale cultivation unit with imaging area of 1000x3300 mm. Each Growth capsule DUAL consists of two independently controlled segments with the main access and operational zone in the middle. Each unit integrates PlantScreen™ Robotic XY system. Robotic imaging module includes 3D laser scanning unit.

Link:

<https://www.plantphenomics.org.au/wp-content/uploads/GROWTH-CAPSULES-200-x-287mm-fact-sheet-web.pdf>

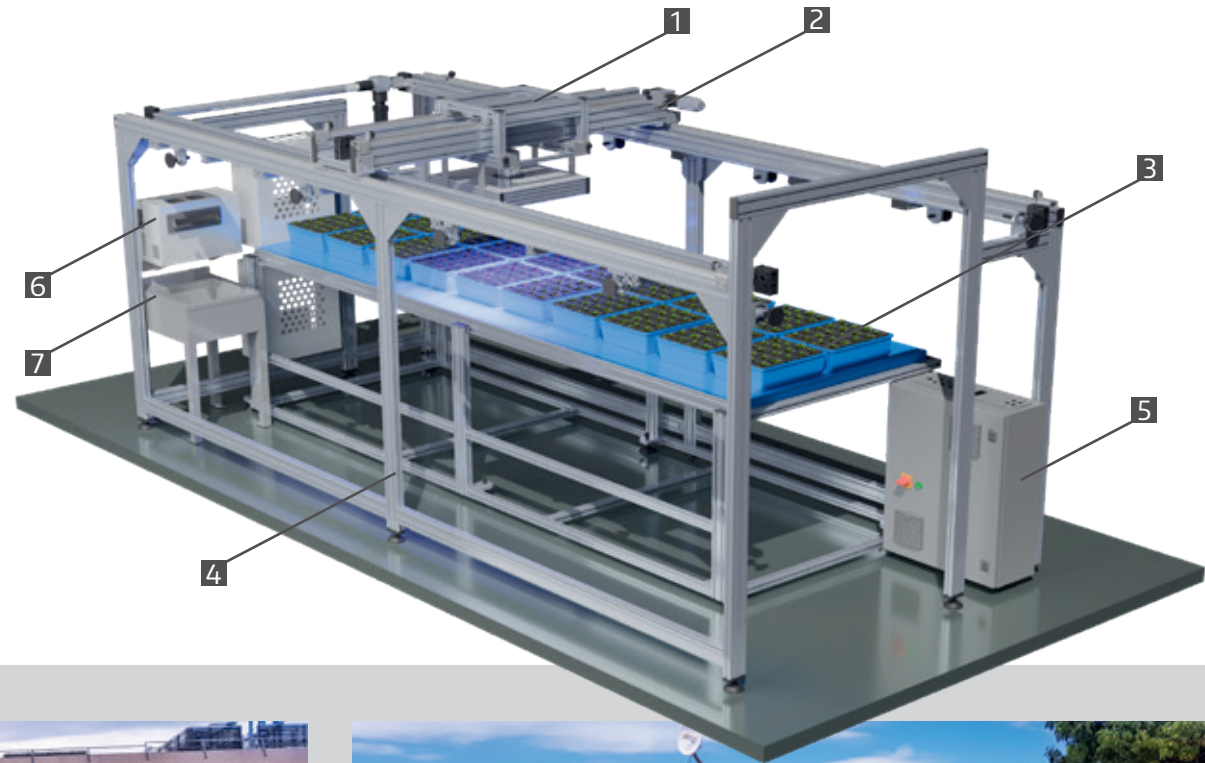


System Specifications

Type of the system	XY
Imaging area of the system	1000x3300 mm
XY axis range	X: 790 mm, Y: 3325 mm
Plant size	65x20 cm
Rating and applications stations	3D laser scanner
Environmental sensors	Light intensity, CO ₂ , temperature and humidity

Layout Schematics

- 1 Imaging module for 3D laser scanner
imaging sensor
- 2 XY moving robotic arm
- 3 Cultivation / imaging area
- 4 Height-adjustable cultivation table
- 5 Control cabinet
- 6 Ultrasonic humidifier
- 7 Dehumidifier



2021

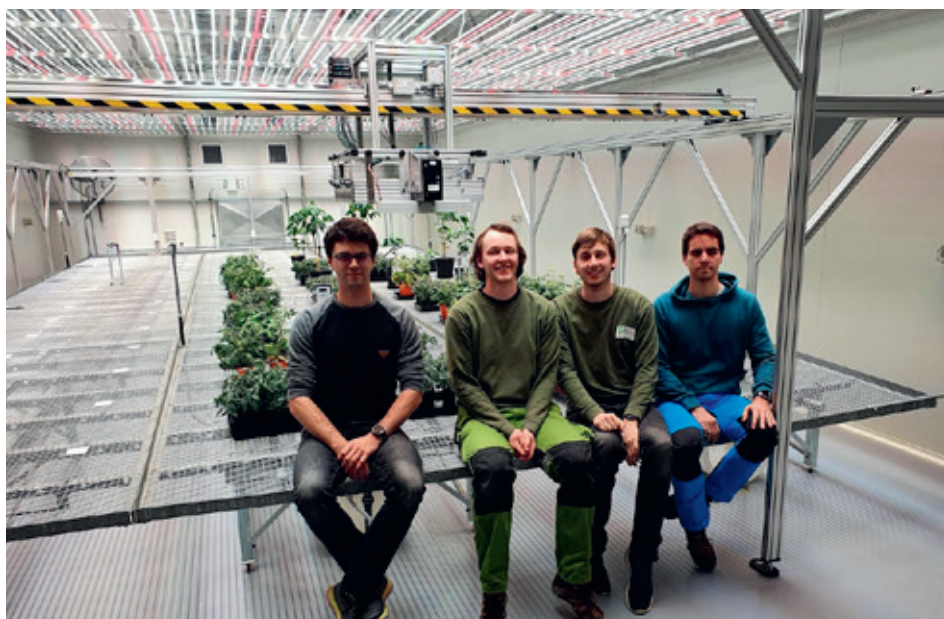
PLANTSCREEN™ XYZ SYSTEM

LA TROBE UNIVERSITY, MELBOURNE, AUSTRALIA

PlantScreen™ XYZ System for plants up to 145 cm in height is installed inside of large-scale cultivation chamber with imaging area of 2520x3600 mm. Robotic imaging module includes RGB morphometric imaging, chlorophyll fluorescence imaging, VNIR hyperspectral imaging and 3D laser scanning. Control of the phenotyping system is fully synchronized with the environmental control of the cultivation chamber.

Link:

<https://medagriculture.com/Research/Capability-and-Platforms>

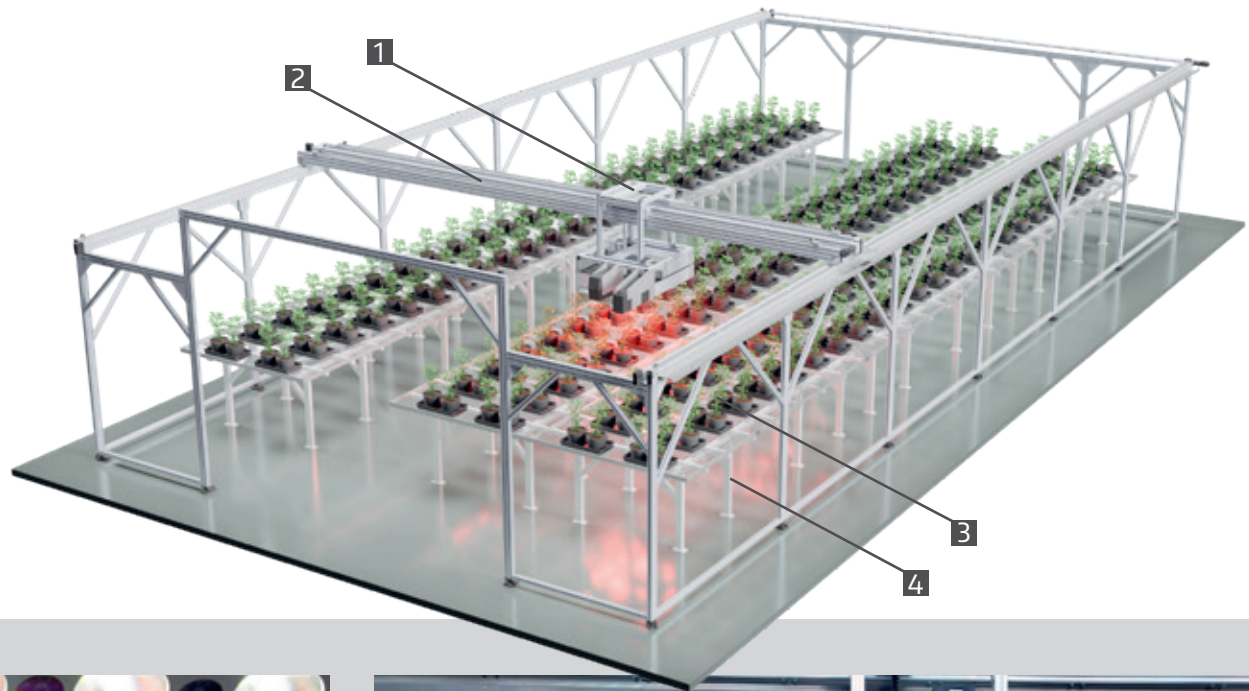


System Specifications

Type of the system	XYZ The system is built inside a growth chamber with controlled light, temperature and humidity condition.
Imaging area of the system	3,600x10,200 mm
XYZ axis range:	X: 4500 mm, Y: 11000, Z: 461
Plant size	100x40 cm
Rating and applications stations	Chlorophyll fluorescence imaging RGB morphometric imaging 3D laser scanning VNIR hyperspectral camera
Environmental sensors	Light intensity, light spectra, CO ₂ , temperature and humidity

Layout Schematics

- 1 Imaging module for FC, RGB, 3D laser and VNIR hyperspectral imaging sensors
- 2 XYZ moving robotic arm
- 3 Cultivation / imaging area
- 4 Position-adjustable cultivation tableless



PLANTSCREEN™ SC ROOT SYSTEM

CEITEC MU, BRNO, CZECH REPUBLIC

The PlantScreen™ SC Root System is designed for small-scale fully automated simultaneous root and shoot phenotyping of small and mid-size crop plants with dimensions up to **80×40 cm**. The system includes **top, side and root specific RGB** imaging unit and is optimized for Rhizobox specific root phenotyping. In parallel photosynthetic performance of the plants can be acquired by kinetic chlorophyll fluorescence imaging.

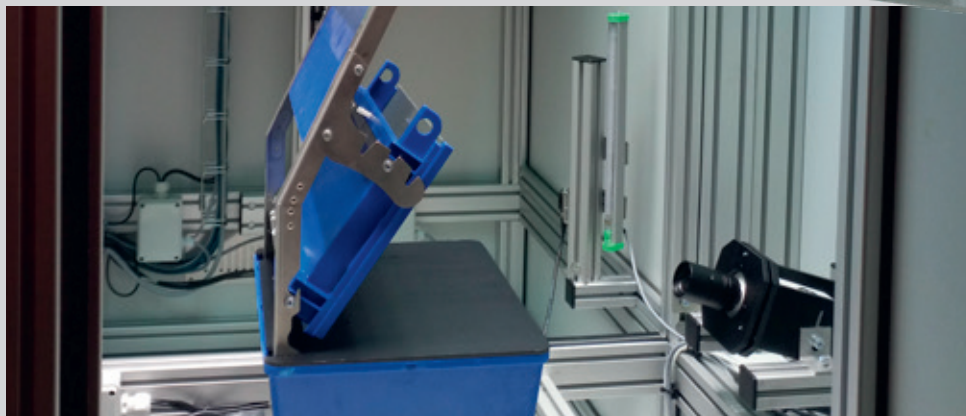
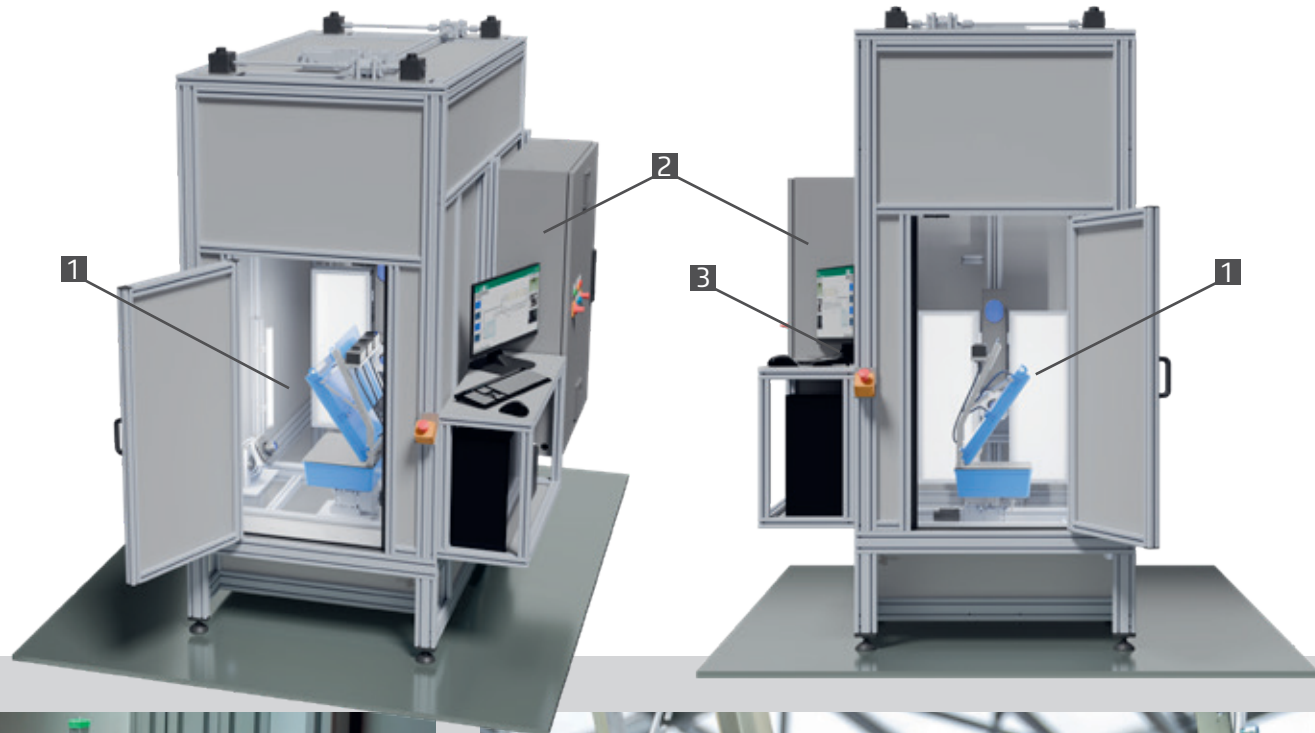


System Specifications

Type of the system	SC Root
Capacity of the system	1 tray
Tray types	Rhizobox, 5×4 (250 ml pots)
Plant size	80×40 cm
Rating and applications stations	RGB morphometric imaging from top and side view Root imaging Chlorophyll fluorescence imaging
Environmental sensors	Temperature and humidity

Layout Schematics

- 1 Chlorophyll fluorescence, shoot and root RGB imaging
- 2 Control cabinet
- 3 Control PC



PLANTSCREEN™ MODULAR SYSTEM IN WALK-IN CHAMBER

VBCF VIENNA BIOCENTER, VIENNA, AUSTRIA

The system is designed for high-throughput phenotyping of small plants up to mid-size crop plants with dimensions up to **70×50 cm**. The system is fully integrated into a state-of-the-art **Walk-In FytoScope Chamber** providing highly homogeneous plant growth condition in **two individually controlled compartments**, i.e. cultivation area and imaging area. The system can accommodate a maximum of **4000 pots** with small size plants as *Arabidopsis* at full capacity. Imaging area is equipped with imaging units and watering and weighing stations. The imaging sensors include **multispectral chlorophyll fluorescence, RGB, thermal, VNIR/SWIR hyperspectral and 3D imaging sensors**.

Link:

<https://www.viennabiocenter.org/vbcf/plant-sciences/phenoplant/>

References:

MUHAMMAD A. ET AL. (2025). *Plant Phenomics*.

DOI:10.1016/j.plaphe.2025.100037

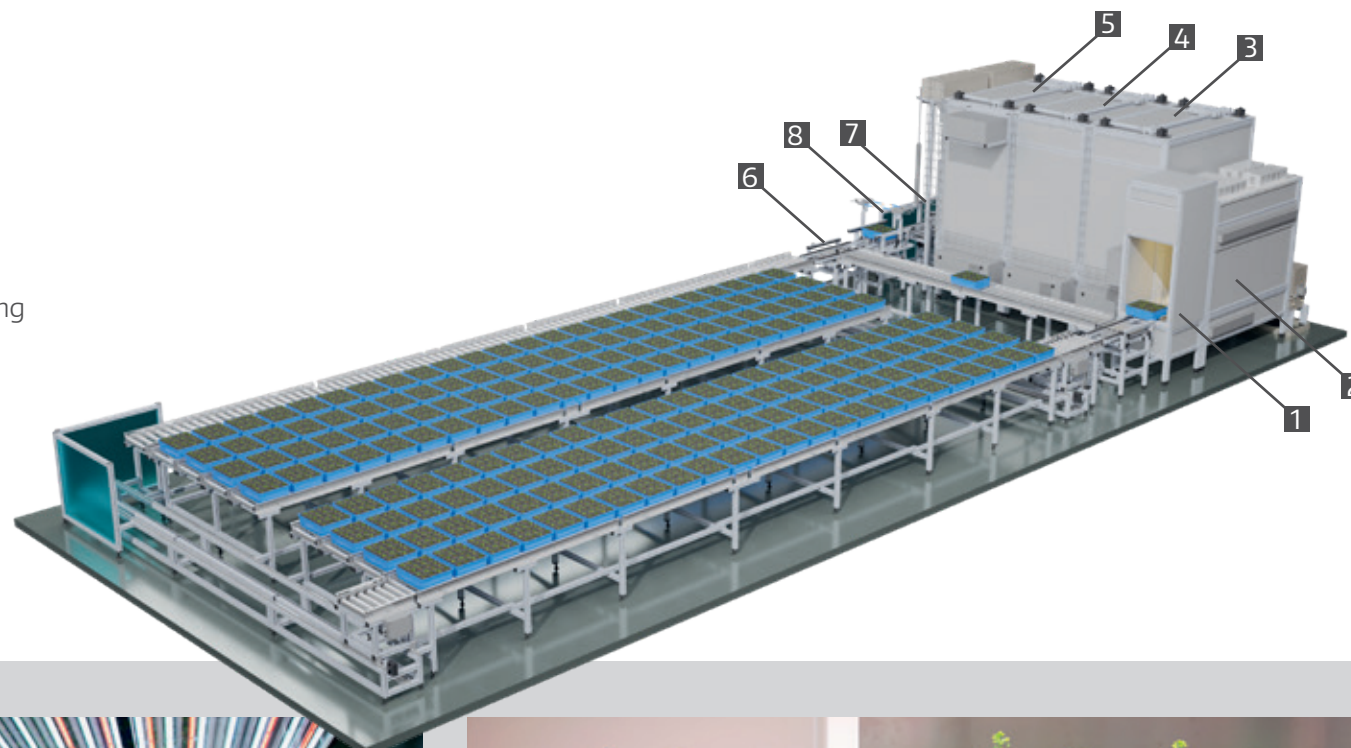


System Specifications

Type of the system	Modular
Capacity of the system	200 trays
Tray types	5×4 pots (250 ml pots), 2×1 (3 l pots) 2×2 pots (2 l pots), 1×1 (5 l pots)
Plant size	70×50 cm
Number of lines in growing buffer	8
Adaptation chamber illumination	Cool white (Maximum intensity 1000 $\mu\text{mol}/\text{m}^2/\text{s}$)
Rating and applications stations	Multispectral chlorophyll fluorescence imaging RGB morphometric imaging from top and side view 3D laser scanning, thermal imaging VNIR/SWIR hyperspectral Imaging Watering and weighing unit for tray types 2x2, 2x1, 1x1 with 2 watering tanks Watering and weighing unit for tray type 5x4 with 2 watering tanks

Layout Schematics

- 1 Light curtain
- 2 Adaptation chamber
- 3 Chlorophyll fluorescence imaging
- 4 Thermal imaging, 3D scanning, RGB imaging
- 5 VNIR/SWIR hyperspectral imaging
- 6 Loading / unloading area
- 7 Watering & Weighing 1
- 8 Watering & Weighing 2



PLANTSCREEN™ XY SYSTEM

NPEC, WAHENINGEN UNIVERSITY, WAGENINGEN, NETHERLANDS

PlantScreen™ XY System with Hydroponic Cultivation for plants up to 45 cm in height is installed inside of large-scale cultivation chamber with imaging area of 2520x3600 mm. The plants are grown hydroponically in individual rock-wool blocks in automatically controlled hydroponic tables. Robotic imaging module includes PAM chlorophyll fluorescence plus multi-color imaging unit and RGB morphometric imaging. Control of the phenotyping system is fully synchronized with the environmental control of the cultivation chamber.

Link:

<https://www.npec.nl/tool/phenovator-ii/>

References:

JURADO-RUIZ, F., NGUYEN, TP., PELLER, J. ET AL. (2024). LeTra: a leaf tracking workflow based on convolutional neural networks and intersection over union. *Plant Methods* 20, 11.

DOI: 10.1186/s13007-024-01138-x

THEEUWEN, T.P.J.M., LAWSON A. W., TIJINK W., ET AL. (2022). The NDH complex reveals a trade-off that constrains maximising photosynthesis in *Arabidopsis thaliana*. *bioRxiv* 2022.11.13.516254;

DOI: 10.1101/2022.11.13.516254

THEEUWEN, T.P.J.M., LOGIE L. L., PUT S., ET AL. (2022). Plethora of QTLs found in *Arabidopsis thaliana* reveals complexity of genetic variation for photosynthesis in dynamic light conditions. *bioRxiv* 2022.11.13.516256;

DOI: 10.1101/2022.11.13.516256

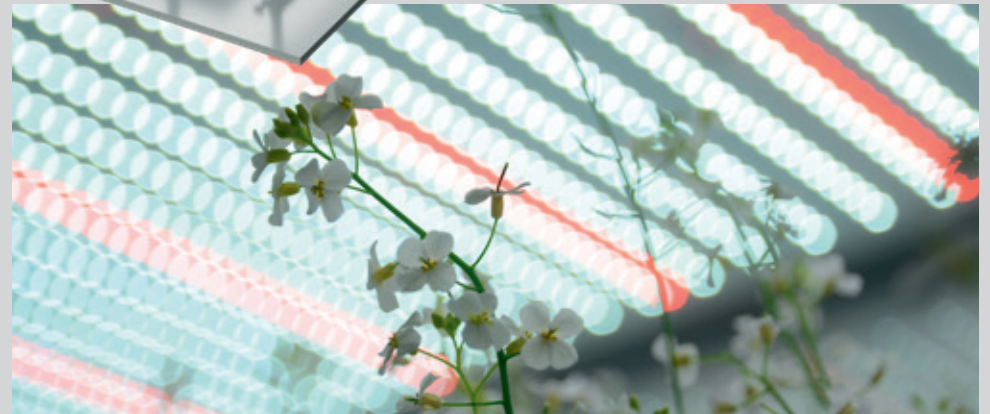
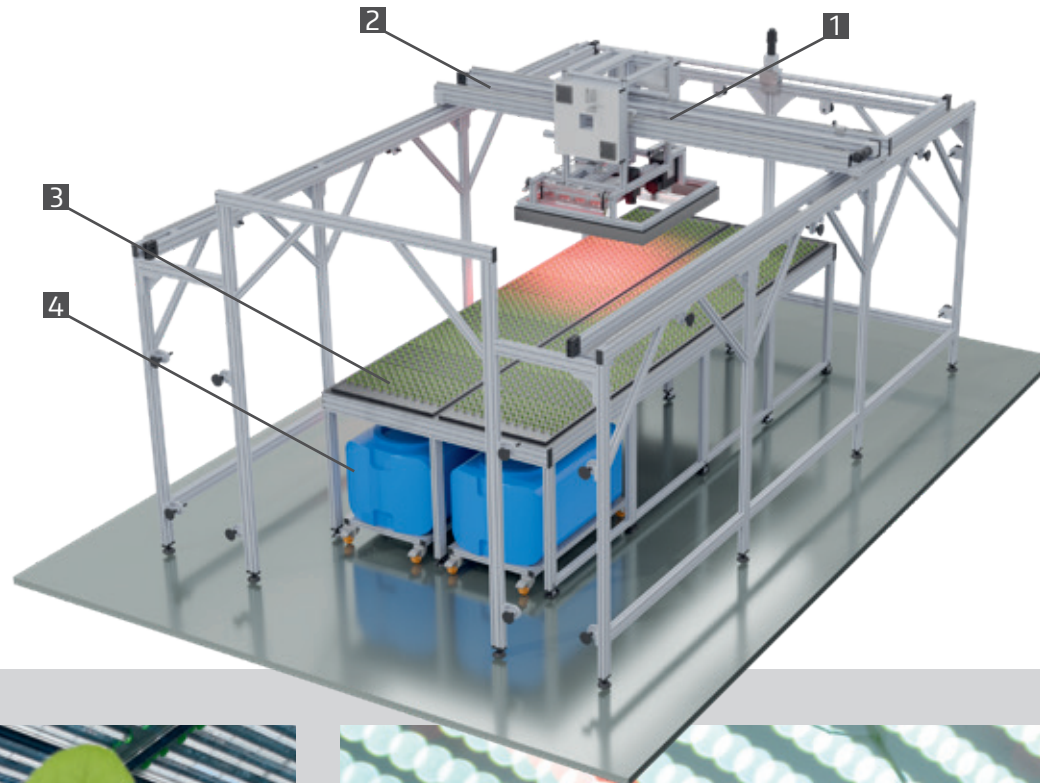


System Specifications

Type of the system	XY System with hydroponic cultivation. The system is built inside a growth chamber with controlled light, temperature and humidity condition.
Imaging area of the system	3570x1420 mm
XY axis range	X: 3970 mm Y: 1480
Plant size	45x20 cm
Rating and applications stations	Multispectral chlorophyll fluorescence imaging RGB morphometric imaging
Environmental sensors	Light intensity, light spectra, CO ₂ , temperature and humidity

Layout Schematics

- 1 Imaging module for FC and RGB imaging sensors
- 2 XY moving robotic arm
- 3 Automatic hydroponic tables
- 4 Nutrient tanks



PLANTSCREEN™ XYZ CRANE SYSTEM

LEIBNIZ INSTITUTE OF PLANT GENETICS AND CROP PLANT RESEARCH, GATERSLEBEN, GERMANY

PlantScreen™ XYZ Crane System for the plants with height up to 300 cm is installed inside of two large cultivation hales of PhenoSphere cultivation infrastructure (Crane I and Crane II). The phenotyping system is designed for top and side view phenotyping of crop plants cultivated in large volume growth containers. 110 large-volume containers (1.5 or 3 m³) can be dynamically scored with the PlantScreen™ XYZ Crane system in two compartments. In each compartment two modules are designed for top and side view imaging. RGB camera, 3D camera, hyperspectral camera, camera for the kinetics of chlorophyll fluorescence are integrated into the imaging modules.

Link:

<https://www.ipk-gatersleben.de/en/infrastructure/phenotyping/ipk-phenosphere>

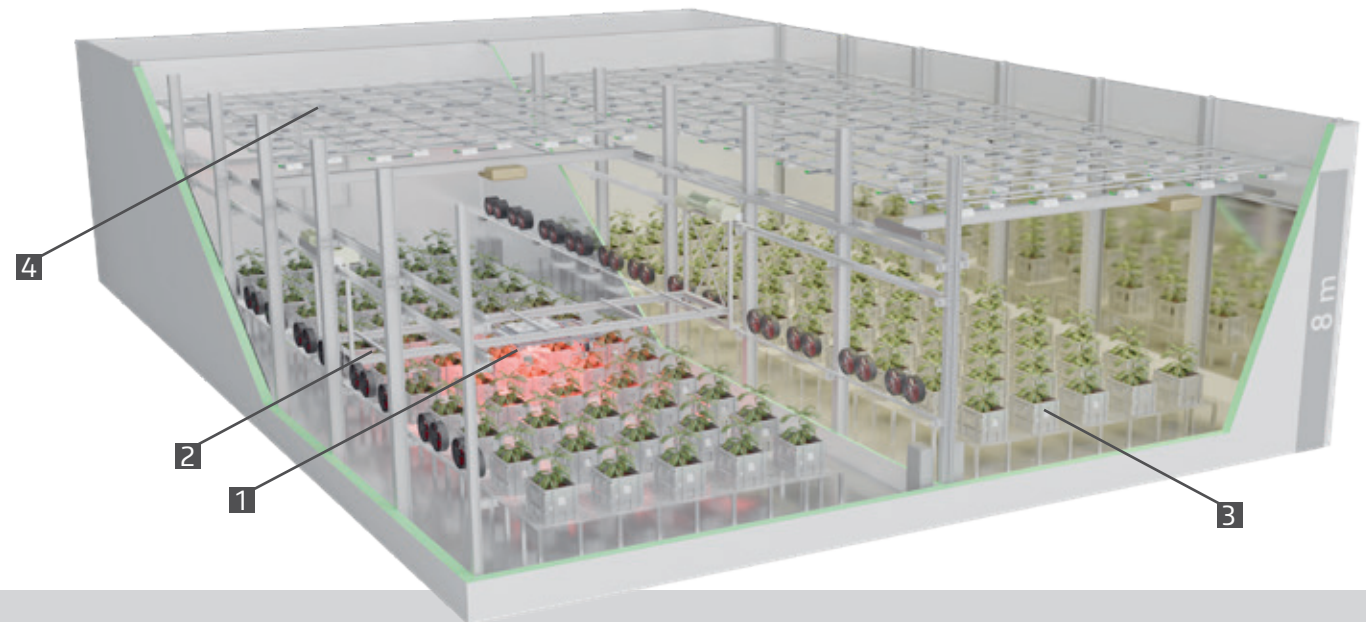


System Specifications

Type of the system	XYZ Crane System with imaging modules for top and side view imaging
Imaging area of the system	880x1320 cm
XY axis range	X: 3970 mm Y: 1480
Plant size	300x100 cm
Rating and applications stations	Chlorophyll fluorescence imaging RGB morphometric imaging VNIR hyperspectral imaging 3D laser scanning

Layout Schematics

- 1 Imaging module for FC, RGB, 3D laser and VNIR hyperspectral imaging sensors
- 2 XYZ moving robotic arm
- 3 Cultivation / imaging area
- 4 Illumination sources

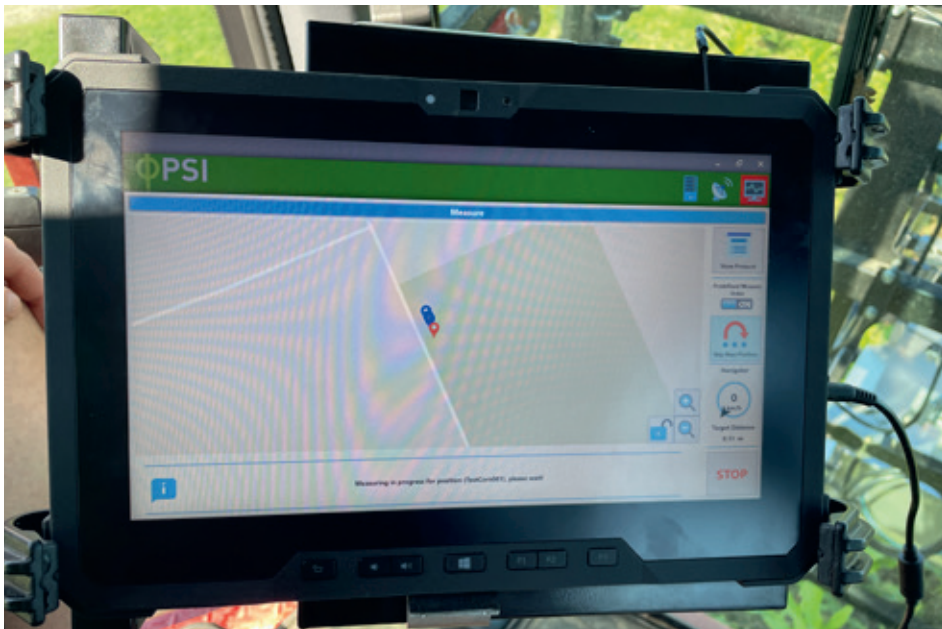


2021

PLANTSCREEN™ ROVER SYSTEM

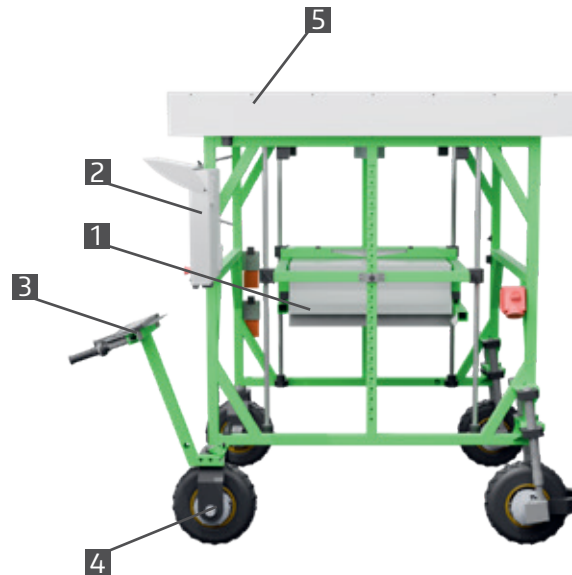
UNIVERSITY OF NOTTINGHAM, UK

Rover FluorCam FC1400-R is smaller-scale electric powered mobile unit for fast and accurate crop phenotyping in the field. The system consists of robust drive mechanisms for operation in the field and water proof construction. PlantScreen™ Rover includes high-sensitivity chlorophyll fluorescence imaging sensor customized for full sunlight operation and integrated satellite navigation RTK GPS/GNSS unit for fully automated and programmable navigation and image acquisition in the field. The system integrates comprehensive SW package and all network components.



Layout Schematics

- 1 Imaging module for FC and RGB imaging sensors
- 2 Control touchscreen PC
- 3 Electric powered drive mechanism
- 4 Robust electric powered wheels
- 5 Water proof construction frame with in built operational bateries



PLANTSCREEN™ FIELD SYSTEM

PLANT BREEDING STRZELCE LTD., POLAND

The PlantScreen™ Field sensor module is modularly mounted on high-clearance field vehicle (e.g. tractor) on height adjustable arm. The module is designed for modular integration of user defined set of imaging sensors. The system navigates the driver with RTK-GPS precision to user defined measuring points and automatically runs the pre-defined measuring protocols. Sensor specific automatic calibration functions are implemented to ensure optimal image exposition and correction implementation for the ambient environmental conditions. After the measurement data are automatically synchronised and stored in the internal database.

References:

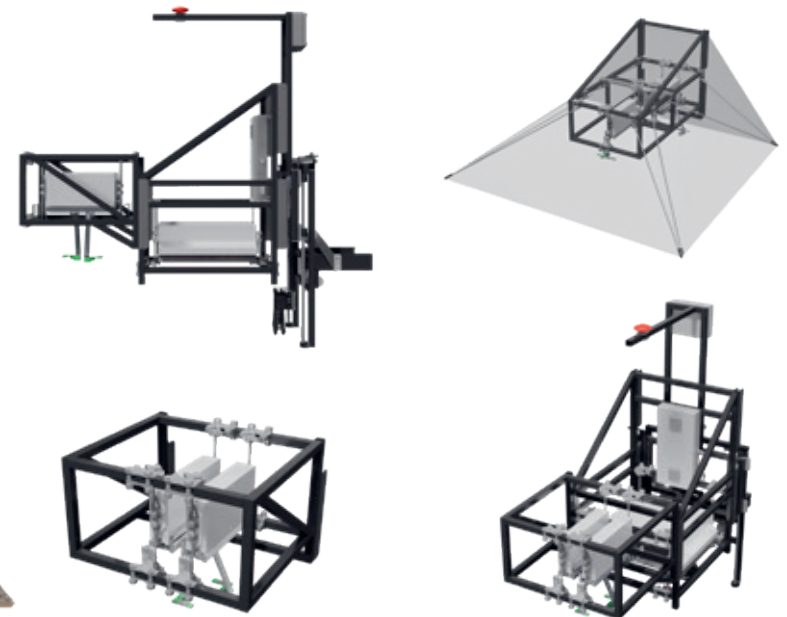
STEFANŃSKI, P., ULLAH, S., MATYSIK, P. ET AL. *Triticale field phenotyping using RGB camera for ear counting and yield estimation. J Appl Genetics* **65**, 271–281 (2024).

<https://DOI.ORG/10.1007/s13353-024-00835-6>



System Specifications

Type of the system	Field System
Imaging area of the system	Up to 100x100 cm
Plant size	Up to 1,5 m
Rating and applications stations	Chlorophyll fluorescence imaging RGB morphometric imaging
Other sensors	Environmental sensors, RTK GPS/GNSS



LIST OF REFERENCES

CZECHIA, PLANTSCREEN™ MODULAR SYSTEM DRASOV

ZAGORŠČAK, M., ABDELHAKIM, L., RODRIGUEZ-GRANADOS, N. Y., ET AL. (2025). *Integration of multi-omics data and deep phenotyping provides insights into responses to single and combined abiotic stress in potato. Plant Physiology*, 197(4).

DOI:10.1093/PLPHYS/KIAF126

ABDELHAKIM, L. O. A., PLESKAČOVÁ, B., RODRIGUEZ-GRANADOS, N. Y., ET AL. (2024). *High Throughput Image-Based Phenotyping for Determining Morphological and Physiological Responses to Single and Combined Stresses in Potato. J. Vis. Exp.* (208), e66255.

DOI:10.3791/66255 (2024).

FINDUROVÁ, H., VESELÁ, B., PANZAROVÁ K., ET AL. (2023). *Phenotyping drought tolerance and yield performance of barley using a combination of imaging methods. Environmental and Experimental Botany. Volume 209.*

DOI: 10.1016/j.envexpbot.2023.105314.

HLAVÁČOVÁ, M., KLEM, K., PYTELA, J., ET AL. (2022). *Yield Formation Parameters of Selected Winter Wheat Genotypes in Response to Water Shortage. Agronomy* 2022, 12, 831.

DOI: 10.3390/agronomy12040831

ULLAH, S.; HENKE, M.; NARISSETTI, N.; PANZAROVÁ, K.; TRTÍLEK, M.; HEJATKO, J.; ET AL. (2021). *Towards Automated Analysis of Grain Spikes in Greenhouse Images Using Neural Network Approaches: A Comparative Investigation of Six Methods. Sensors* 21, 7441.

DOI: 10.3390/s21227441

ABDELHAKIM, L. O. A., ROSENQVIST, E., WOLLENWEBER, B., OTTOSEN, C.-O., & PANZAROVÁ, K., ET AL. (2021). *Investigating Combined Drought- and Heat Stress Effects in Wheat under Controlled Conditions by Dynamic Image-Based Phenotyping. Agronomy*, 11(2), 364.

DOI:10.3390/agronomy11020364

PAUL K., SORRENTINO M., LUCINI L., ROUPHAEL Y.F, CARDARELLI M., ET AL. (2019). *A Combined Phenotypic and Metabolomic Approach for Elucidating the Biostimulant Action of a Plant-derived Protein Hydrolysate on Tomato Grown under Limited Water Availability. Frontiers in Plant Science.*

DOI: 10.3389/fpls.2019.00493

PAUL K, SORRENTINO M, LUCINI L, ROUPHAEL Y, CARDARELLI M., ET AL. (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.

DOI: 10.3389/fpls.2019.00047

CZECHIA, PLANTSCREEN™ COMPACT SYSTEM DRASOV

SORRENTINO M., PANZAROVÁ K., SPYROGLOU I., SPÍCHAL L., ET AL. (2022). *Integration of Phenomics and metabolomics Datasets Reveals Different Mode of Action of Biostimulants Based on Protein Hydrolysates in Lactuca sativa L. and Solanum lycopersicum L. Under Salinity. Front. Plant Sci.* 12:808711.

DOI: 10.3389/fpls.2021.808711

SORRENTINO M., COLLA G., ROUPHAEL Y, PANZAROVÁ K., TRTÍLEK M. (2020). *Lettuce reaction to drought stress: automated high-throughput phenotyping of plant growth and photosynthetic performance. ISHS Acta Horticulturae* 1268.

DOI: 10.17660/ActaHortic.2020.1268.17

FLÜTSCH S., NIGRO A., CONCI F., FAJKUS J., THALMANN M., TRTÍLEK M., PANZAROVÁ K., ET AL. (2020). *Glucose uptake to guard cells via STP transporters provides carbon sources for stomatal opening and plant growth. EMBO Reports* (2020) 21.

DOI: 10.15252/embr.201949719

AWLIA, M., NIGRO, A., FAJKUS, J., SCHMOECKEL, S. M., NEGRÃO, S. ET AL (2016). *High-throughput non-destructive phenotyping of traits that contribute to salinity tolerance*



in *Arabidopsis thaliana*. *Frontiers in Plant Science*, 7, 1–15.

DOI:10.3389/FPLS.2016.01414

ŠMERINGAI J., RUDOLF J., TRTÍLEK M., ET AL. (2023). Shoot phenotyping of cytokinin receptors mutants revealed fluorescence parameters as early markers of drought stress. *BioRxiv* 2023.11.30.569457.

DOI: 10.1101/2023.11.30.569457

BALAKHONOVA, V., PUSHKAROVA, N., SKALAK, J., ET AL. (2024). Non-invasive Assay for Chlorophyll Biosynthesis Kinetics Determination during Early Stages of *Arabidopsis* De-etiolation. *J. Vis. Exp.* (2023), e66087.

DOI:10.3791/66087

BALAKHONOVA V., DOBISOVA T., BENEDIKTY Z., PANZAROVA K., PYTELA J., KOCI R., ET AL. (2023) iReenCAM: automated imaging system for kinetic analysis of photosynthetic pigment biosynthesis at high spatiotemporal resolution during early deetiolation. *Front. Plant Sci.* 14:1093292.

DOI: 10.3389/fpls.2023.1093292

CZECHIA, PLANTSCREEN™ SC ROOT, BRNO, CEITEC

NAGHANI S. E., ŠMERINGAI J., PLESKAČOVÁ B. ET AL. (2024). Integrative phenotyping approaches to unmask the *PhyB-PIF4* pathway in *Arabidopsis thaliana* reproductive organs at high ambient temperatures, 15 April 2024, PREPRINT (Version 1) available at Research Square.

DOI: 10.21203/rs.3.rs-4223427/v1

CZECHIA, PLANTSCREEN™ XYZ SYSTEM, OLOMOUC, UPOL

PUNCHKHON C., CHUTIMANUKUL P., CHOKWIWATKUL R., ET AL. (2022). S. Role of *LOC_Os01g68450*, Containing *DUF2358*, in *Salt Tolerance Is Mediated via Adaptation of*

Absorbed Light Energy Dissipation. *Plants* 11, 1233.

DOI: 10.3390/plants11091233

BLICHARZ, S., BEEMSTER, G. T. S., RAGNI, L., DE DIEGO, N., SPÍČHAL, L., ET AL. (2021). Phloem exudate metabolic content reflects the response to water-deficit stress in pea plants (*Pisum sativum* L.). *The Plant Journal*, 106(5), 1338–1355.

DOI:10.1111/tpj.15240

SORRENTINO M., DE DIEGO N., UGENA L., ET AL. (2021). Seed Priming With Protein Hydrolysates Improves *Arabidopsis* Growth and Stress Tolerance to Abiotic Stresses. *Front. Plant Sci.* 12:626301.

DOI: 10.3389/fpls.2021.626301

BRYKSOVÁ M., HYBENOVÁ A., HERNÁNDIZ A.E., ET AL. (2020) Hormopriming to Mitigate Abiotic Stress Effects: A Case Study of N9 -Substituted Cytokinin Derivatives With a Fluorinated Carbohydrate Moiety. *Front. Plant Sci.* 11:599228.

DOI: 10.3389/fpls.2020.599228

NISLER J., KOPEČNÝ D., PĚKNÁ Z., KONČITÍKOVÁ R., KOPRNA R., MURVANIDZE N., ET AL. (2020). Diphenylurea-derived cytokinin oxidase/dehydrogenase inhibitors for biotechnology and agriculture. *Journal of Experimental Botany*, 72(2), 355–370.

DOI:10.1093/jxb/eraa437

PUNCHKHON C., PLAIMAS K., BUABOOCHA T., SIANGLIW J.L., TOOJINDA T., COMAI L., ET AL. (2020). Drought-Tolerance Gene Identification Using Genome Comparison and Co-Expression Network Analysis of Chromosome Substitution Lines in Rice. *Genes*. 11(10):1197.

DOI: 10.3390/genes11101197

AMEZTOY, K., BASLAM, M., SÁNCHEZ-LÓPEZ, Á. M., MUÑOZ, F. J., ET AL. (2019). Plant responses to fungal volatiles involve global post-translational thiol redox proteome changes that affect photosynthesis. *Plant, Cell & Environment*.

DOI:10.1111/pce.13601

JANEČKOVÁ, H., HUSIČKOVÁ, A., LAZÁR, D., FERRETTI, U., POSPÍŠIL, P., & ŠPUNDOVÁ, M. (2019). Exogenous application of cytokinin during dark senescence eliminates the acceleration of photosystem II impairment caused by chlorophyll b deficiency in barley. *Plant Physiology and Biochemistry*, 136.
DOI: 10.1016/J.PLAPHY.2019.01.005

MARCHETTI, C. F., UGENA, L., HUMPLÍK, J. F., POLÁK, M., ET AL. (2019). A Novel Image-Based Screening Method to Study Water-Deficit Response and Recovery of Barley Populations Using Canopy Dynamics Phenotyping and Simple Metabolite Profiling. *Frontiers in Plant Science*, 10.
DOI:10.3389/fpls.2019.01252

CZECHIA, PLANTSCREEN™ COMPACT, OLOMOUC, UPOL

HUSIČKOVÁ, A., HUMPLÍK, J. F., HÝBL, M., SPÍCHAL, L., & LAZÁR, D. (2019). Analysis of Cold-Developed vs. Cold-Acclimated Leaves Reveals Various Strategies of Cold Acclimation of Field Pea Cultivars. *Remote Sensing*, 11(24), 2964.
DOI:10.3390/rs11242964

POLAND, PLANTSCREEN™ SC MINI, POZNAN, AMU

CHOJNACKA, A., SMOCZYNSKA, A., BIELEWICZ, D. ET AL. (2023) PEP444c encoded within the MIR444c gene regulates microRNA444c accumulation in barley. *Physiologia Plantarum*, 175(5), e14018. Available
DOI: 10.1111/ppl.14018

CZEMBOR, E., CZEMBOR, J.H., SUCHECKI, R. ET AL. (2021). DArT-based evaluation of soybean germplasm from Polish Gene Bank. *BMC Res Notes* 14, 343.
DOI: 10.1186/s13104-021-05750-1

POLAND, PLANTSCREEN™ FIELD SYSTEM, STRZELCE

STEFANŃSKI P., RYBKA K., MATYSIK P. (2024). Phenotyping of winter triticale canopy density in field conditions using an RGB camera. *BIULETYN IHAR*.
DOI: 10.37317/biul-2024-0001

SLOVAKIA, PLANTSCREEN™ MODULAR SYSTEM, SPU NITRA

SYTAR O., KOVÁR M., BRESTIC M., ET AL. (2023) Cultivar-dependent and drought-induced modulation of secondary metabolites, adaptative defense in *Fagopyrum esculentum* L. *Physiol Mol Biol Plants* 29, 1605–1618 (2023).
DOI: 10.1007/s12298-023-01376-8

FERRONI, L., ŽIVČAK, M., SYTAR, O., KOVÁR, M., ET AL. (2020). Fast chlorophyll a fluorescence induction (OJIP) phenotyping of chlorophyll-deficient wheat suggests that an enlarged acceptor pool size of Photosystem I helps compensate for a deregulated photosynthetic electron flow. *Volume 234*.
DOI: 10.1016/j.jphotobiol.2022.112549.

FERRONI, L., ŽIVČAK, M., SYTAR, O., KOVÁR, M., WATANABE, N., ET AL. (2020). Chlorophyll-depleted wheat mutants are disturbed in photosynthetic electron flow regulation but can retain an acclimation ability to a fluctuating light regime. *Environmental and Experimental Botany*, 104156.
DOI: 10.1016/j.envexpbot.2020.1041

HUNGARY, PLANTSCREEN™ COMPACT SYSTEM, HAS SZEGED

KANT, K., RIGÓ, G., FARAGÓ, D. ET AL. (2024). Mutation in *Arabidopsis* mitochondrial Pentatricopeptide repeat 40 gene affects tolerance to water deficit. *Planta* 259, 78.

DOI: 10.1007/s00425-024-04354-W

FINLAND, PLANTSCREEN™ SC, HELSINKI, LUKE

PUNKKINEN M., BLOKHINA O., PERALTA L. L., ET AL. (2024). Mitochondria affect photosynthesis through altered tissue levels of oxygen. *BioRxiv* 07.19.604342;
DOI: 10.1101/2024.07.19.604342

FINLAND, PLANTSCREEN™ CONVEYOR SYSTEM, NAPPI PLATFORM AT THE UNIVERSITY OF HELSINKI

PAVICIC M., MOUHU K., HAUTSALO J., ET AL. (2023) Image-based time series analysis to establish differential disease progression for two *Fusarium* head blight pathogens in oat spikelets with variable resistance. *Front. Plant Sci.* 14:1126717.
DOI: 10.3389/fpls.2023.1126717

POLLARI, M.; SIPARI, N.; POQUE, S.; ET AL. (2023) Effects of Poty-Potexvirus Synergism on Growth, Photosynthesis and Metabolite Status of *Nicotiana benthamiana*. *Viruses* 2023, 15, 121.
DOI: 10.3390/v15010121

PANLONEN, P., LAINE, T. AND MOUHU, K. (2021). Floricane yield and berry quality of seven primocane red raspberry (*Rubus idaeus* L.) cultivars. *Scientia Horticulturae*, 285, 110201.
DOI: 10.1016/j.scienta.2021.110201

PAVICIC, M.; OVERMYER, K.; REHMAN A. U. ET AL. (2021). Image-Based Methods to Score Fungal Pathogen Symptom Progression and Severity in Excised *Arabidopsis* Leaves. *Plants* 2021, 10, 158.
DOI: 10.3390/plants10010158

HÖCKERSTEDT, L., SUSI, H., & LAINE, A. (2020). Effect of maternal infection on progeny growth and resistance mediated by maternal genotype and nutrient availability. *Journal of Ecology*.
DOI:10.1111/1365-2745.13568

PAVICIC, M., WANG, F., MOUHU, K. ET AL. (2019). High throughput in vitro seed germination screen identified new ABA responsive RING-type ubiquitin E3 ligases in *Arabidopsis thaliana*. *Plant Cell Tiss Organ Cult* 139, 563–575.
DOI: 10.1007/s11240-019-01700-9

RUNGRAT T., ALMONTE A. A., CHENG R., ET AL. (2019) A Genome-Wide Association Study of Non-Photochemical Quenching in response to local seasonal climates in *Arabidopsis thaliana*, *bioRxiv* 539379;
DOI: <https://doi.org/10.1101/539379>

WANG, L., POQUE, S. & VALKONEN, J.P.T. (2019). Phenotyping viral infection in sweetpotato using a high-throughput chlorophyll fluorescence and thermal imaging platform. *Plant Methods* 15, 116.
DOI: 10.1186/s13007-019-0501-1

WEN, Z., RAFFAELLO, T., ZENG, Z., PAVICIC, M., & ASIEGBU, F. O. (2019). Chlorophyll fluorescence imaging for monitoring effects of *Heterobasidion parviporum* small secreted protein induced cell death and in planta defense gene expression. *Fungal Genetics and Biology*.
DOI: 10.1016/j.FGB.2019.02.003

ENGLAND, PLANTSCREEN™ MODULAR SYSTEM, ABERYSTWYTH UNIVERSITY

GIRIJA, A., HAN, J., CORKE, F., BROOK, J., DOONAN, J., YADAV, R. ET AL. (2022) Elucidating drought responsive networks in *tef* (*Eragrostis tef*) using phenomic and metabolomic approaches. *Physiologia Plantarum*, 174(1).
DOI: 10.1111/ppl.13597

MORON-GARCIA O., GARZON-MARTINEZ G.A., MARTINEZ-MARTIN M.J.P, ET AL. (2022) Genetic architecture of variation in *Arabidopsis thaliana* rosettes. *PLoS ONE* 17(2):e0263985.

DOI: 10.1371/journal.pone.0263985

ENGLAND, PLANTSCREEN™ TRANSECT SYSTEM, THE UNIVERSITY OF SHEFFIELD

HÖRAK H., ROLFE S. A., TON J., ET AL. (2023). NPR1 protects young leaves from systemic salicylic acid-induced damage during bacterial infection. *bioRxiv* 2023.08.21.554086.

DOI: 10.1101/2023.08.21.554086

NETHERLANDS, PLANTSCREEN™ SC, WAGENINGEN WUR

BENGOA LUONI, S.A., GARASSINO, F., AARTS, M.G.M. (2024). A High-Throughput Approach for Photosynthesis Studies in a Brassicaceae Panel. In: Maghuly, F. (eds) *Plant Functional Genomics. Methods in Molecular Biology*, vol 2787. Humana, New York, NY.

DOI: 10.1007/978-1-0716-3778-4_2

GARASSINO, F. (2023): Supplementary information: Analysis of natural variation in photosynthesis in a panel of Brassicaceae species. Version 2. 4TU.ResearchData. dataset.

DOI: 10.4121/79a62b5f-2881-4520-b031-e03334c02aad.v2

JARAMILLO ROMAN V., VAN DE ZEDDE R., PELLER J., ET AL. (2021) High-Resolution Analysis of Growth and Transpiration of Quinoa Under Saline Conditions. *Front. Plant Sci.* 12:634311.

DOI: 10.3389/fpls.2021.634311

NETHERLANDS, PLANTSCREEN™ XY, WAGENINGEN, WUR

JURADO-RUIZ, F., NGUYEN, TP., PELLER, J. ET AL. (2024). LeTra: a leaf tracking workflow based on convolutional neural networks and intersection over union. *Plant Methods* 20, 11.

DOI: 10.1186/s13007-024-01138-x

THEEUWEN, T.P.J.M., LAWSON A. W., TIJINK W., ET AL. (2022). The NDH complex reveals a trade-off that constrains maximising photosynthesis in *Arabidopsis thaliana*. *bioRxiv* 2022.11.13.516254.

DOI: 10.1101/2022.11.13.516254

THEEUWEN, T.P.J.M., LOGIE L. L., PUT S., ET AL. (2022). Plethora of QTLs found in *Arabidopsis thaliana* reveals complexity of genetic variation for photosynthesis in dynamic light conditions. *bioRxiv* 2022.11.13.516256.

DOI: 10.1101/2022.11.13.516256

ITALY, PLANTSCREEN™ SC, PIACENZA, UNIVERSITY OF CATTOLICA

SECOMANDI E., DE GREGORIO M. A., CASTRO-CEGRÍA, ET AL. (2024). Single and combined effect of salinity, heat, cold, and drought in *Arabidopsis* at metabolomics and photosynthetic levels. *bioRxiv* 2024.06.23.600276.

DOI: 10.1101/2024.06.23.600276

FRANCE, PLANTSCREEN™ MODULAR SYSTEM, UPJV AMIENS

BARBUT F.R., CAVEL E., DONEV E.N., ET AL. (2024). Integrity of xylan backbone affects plant responses to drought. *Front Plant Sci.* 2024 Jun 25;15:1422701.

DOI: 10.3389/fpls.2024.1422701



MAILLOT, Y. MONGELARD, G., QUÉRO, A.; ET AL. (2023). Pathogen Stopping and Metabolism Modulation Are Key Points to *Linum usitatissimum* L. Early Response against *Fusarium oxysporum*. *Plant* 12, 1963.

DOI: 10.3390/plants12101963

ISRAEL, PLANTSCREEN™ COMPACT, TEL AVIV UNIVERSITY

HONIG, A., EILENBERG H., ZUTHER E., (2022). CWLP and PRP940 form plasma-membrane nanodomain complexes with aquaporins, interact with PP2A and contribute to dehydration tolerance. *bioRxiv* 2022.10.20.512913.

DOI: 10.1101/2022.10.20.512913

SINGH, A. K., YADAV, B. S., DHANAPAL, S. ET AL. (2019). CSN5A Subunit of COP9 Signalosome Temporally Buffers Response to Heat in *Arabidopsis*. *Biomolecules* 2019, 9, 805. *Biomolecules* 805.

DOI:10.3390/biom9120805

SAUDI ARABIA, PLANTSCREEN™ MODULAR, KAUST

SHEIKH A. H., TABASSUM N., RAWAT A., ET AL. (2024). m6A RNA methylation counteracts dark-induced leaf senescence in *Arabidopsis*, *Plant Physiology*, Volume 194, Issue 4.

DOI: 10.1093/plphys/kiad660

AWLIA, M., ALSHAREEF, N., SABER, N., KORTE, ET AL. (2021). Genetic mapping of the early responses to salt stress in *Arabidopsis thaliana*. *Plant J*, 107: 544-563.

DOI: 10.1111/tpj.15310

AWLIA M., ALSHAREEF N., SABER N., K. PANZAROVÁ, M. TRTÍLEK., ET AL. (2020). Genetic mapping of the early responses to salt stress in *Arabidopsis thaliana*. *bioRxiv*.

DOI: 10.1101/2020.10.02.324178

GAO, G., TESTER, M. A., & JULKOWSKA, M. M. (2020). The use of high-throughput phenotyping for assessment of heat stress-induced changes in *arabidopsis*. *Plant Phenomics*, 2020.

DOI: 10.34133/2020/3723916

GAO G., TESTER M. A., JULKOWSKA M. M. (2019). The use of high throughput phenotyping for assessment of heat stress-induced changes in *Arabidopsis*. *Biorxiv*.

DOI: 10.1101/838102

JULKOWSKA, M. M., SAADE, S., AGARWAL, G., GAO, G., PAILLES, Y., ET AL. (2019). MVApp - Multivariate analysis application for streamlined data analysis and curation. *Plant Physiology*, pp.00235.2019.

DOI:10.1104/PP.19.00235

SOUTH KOREA, PLANTSCREEN™ XYZ, JEONJU, NIAS

KIM, S.L., KIM, N., LEE, H. ET AL. (2020). High-throughput phenotyping platform for analyzing drought tolerance in rice. *Planta* 252, 38.

DOI: 10.1007/s00425-020-03436-9

UNITED STATES OF AMERICA, PLANTSCREEN™ TRANSECT XZ SYSTEM, USDA ARS, SALINAS, CALIFORNIA

KUMAR, P., ERIKSEN, R.L., SIMKO, I. ET AL. (2022). Insights into nitrogen metabolism in the wild and cultivated lettuce as revealed by transcriptome and weighted gene co-expression network analysis. *Sci Rep* 12, 9852.

DOI: 10.1038/s41598-022-13954-z

KUMAR P., ERIKSEN R. L., SIMKO I., ET AL. (2021). *Insights into Nitrogen Metabolism in the Wild and Cultivated Lettuce as Revealed by Transcriptome and Weighted Gene Co-Expression Network Analysis.* Research Square.

DOI: 10.21203/rs.3.rs-749020/v1

KUMAR P., ERIKSEN R.L., SIMKO I. AND MOU B. (2021). *Molecular Mapping of Water-Stress Responsive Genomic Loci in Lettuce (Lactuca spp.) Using Kinetics Chlorophyll fluorescence, Hyperspectral Imaging and Machine Learning.* Front. Genet. 12:634554.

DOI: 10.3389/fgene.2021.634554

ADHIKARI N. D., SIMKO I., MOU B. (2019). *Phenomic and Physiological Analysis of Salinity Effects on Lettuce.* Sensors 19, 4814.

DOI: 10.3390/s19214814

AUSTRALIA, PLANTSCREEN™ MODULAR SYSTEM, CANBERRA, CSIRO

CHATTERJEE, J., COE, R. A., ACEBRON, K., THAKUR, V., YENNAMALLI, R. M., ET AL. (2021). *Identification of a low CO₂ responsive mutant from chemical mutagenesis of Setaria viridis shows that reduced carbonic anhydrase severely limits C₄ photosynthesis.* Journal of Experimental Botany.

DOI: 10.1093/jxb/erab039

GONZALEZ-BAYON, R., SHEN, Y., GROSZMANN, M., ZHU, A., WANG, A., ET AL. (2019). *Senescence and defense pathways contribute to heterosis.* Plant Physiology, pp.01205.2018.

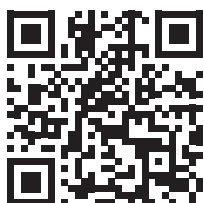
DOI:10.1104/pp.18.01205







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