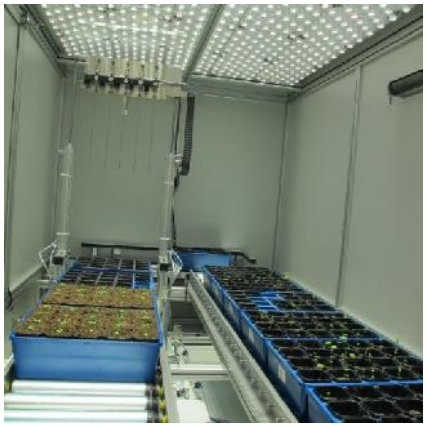
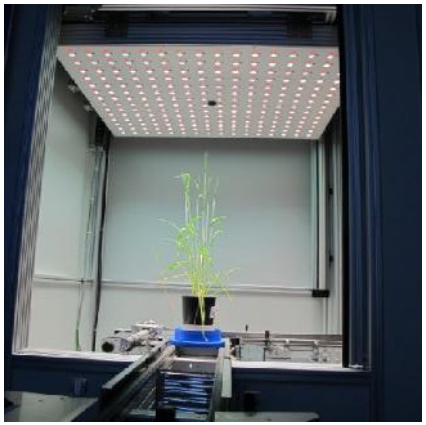
High-throughput screening tools for identification of traits contributing to salinity tolerance in *Arabidopsis thaliana*



Klára Panzarová

Canberra, 23.9. 2016

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5th International Controlled Environment Conference | AusPheno 2016

Professional Instruments for Plant and Algae Biotechnology

Tradition & Innovation

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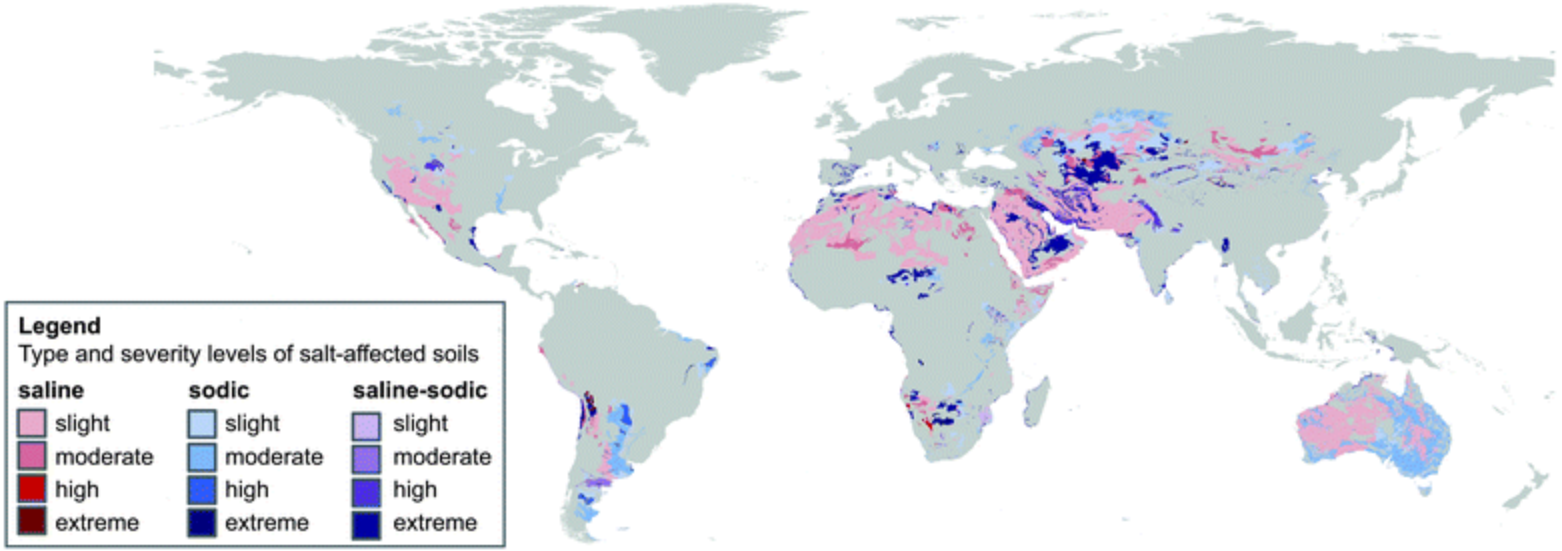
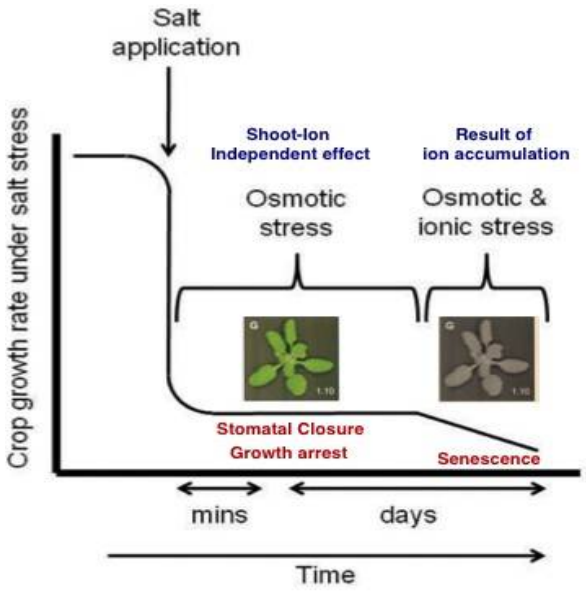
…from the Czech Republic since 1994

Soil salinity



FAO, 2008



Munns & Tester, 2008

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Arianna Nigro

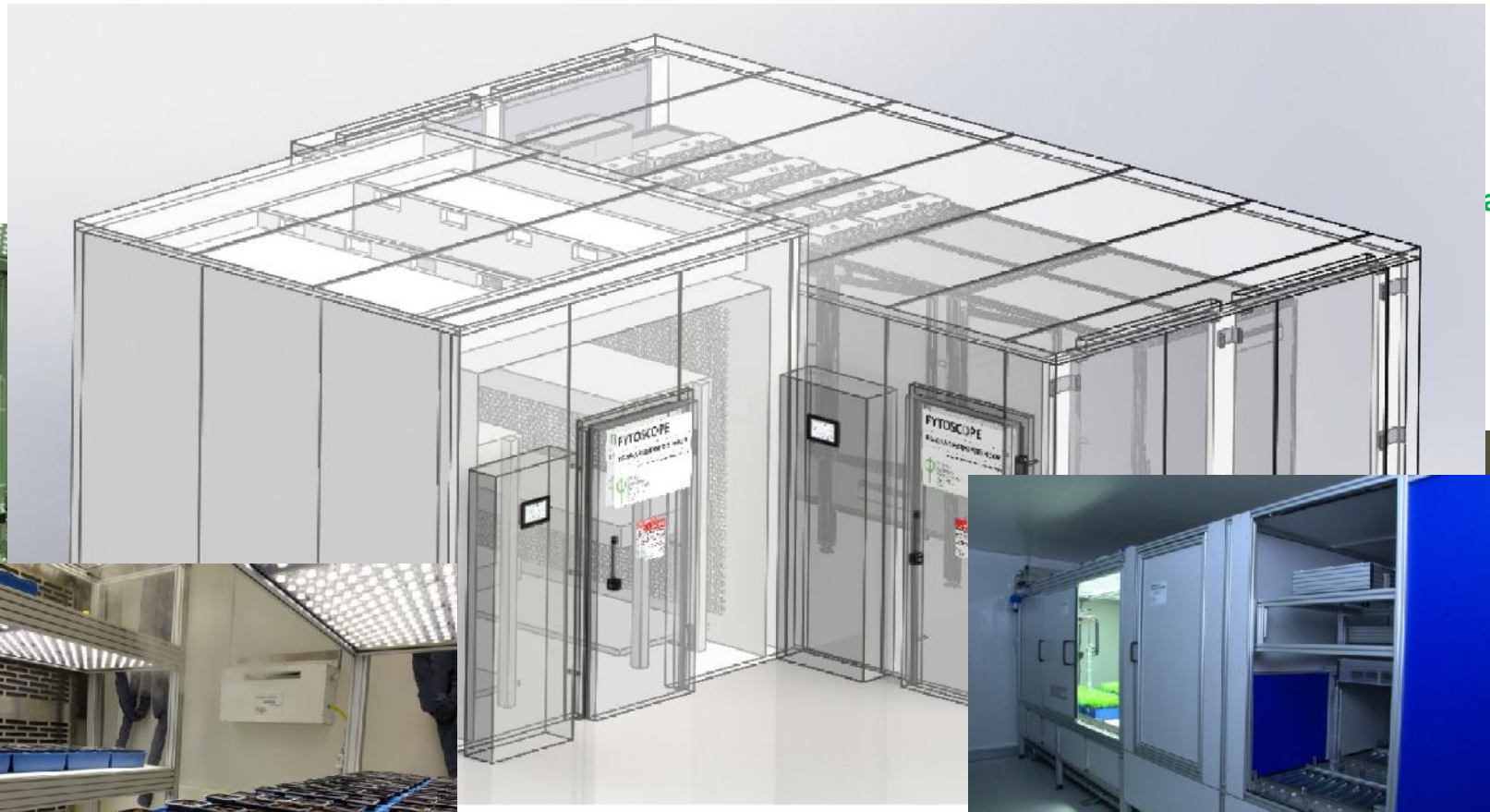
PSI Team

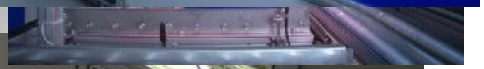
Radka Mezulaniková

Jiří Fajkus

Petr Polach

Automated phenotyping in controlled environment





Method for screening plant performance under salinity stress

PlantScreen™

Automated weighing – watering system

Water use monitoring

PlantScreen™

RGB camera

Plant growth rate
Plant morpohology
Color analysis

PlantScreen™

Chlorophyll fluorescence camera

Photosynthetic performance

Morphological and color analysis with RGB imaging

Color segmented image

RGB image

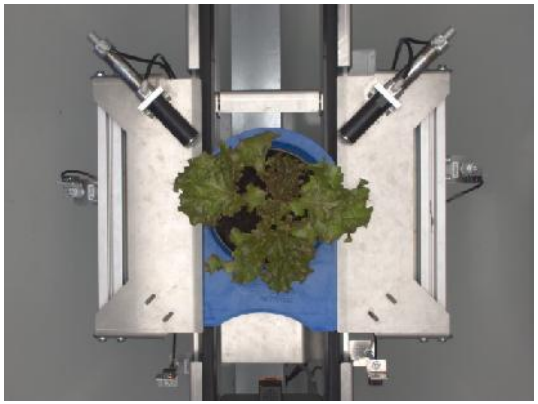
Applications

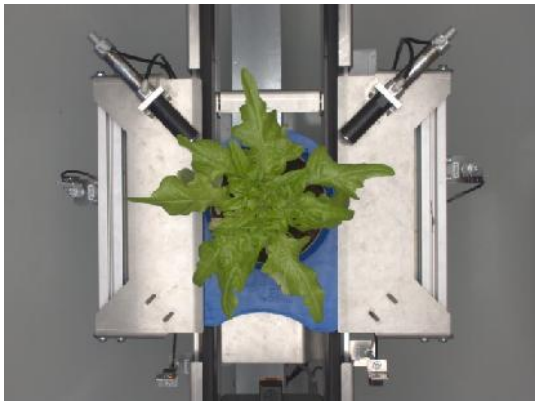
Shoot biomass, growth dynamics, shoot shape, color index,…

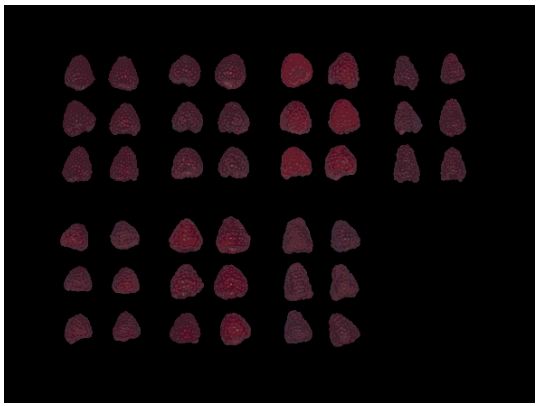
- ✓Area
- ✓Perimeter
- ✓Roundness
- ✓Compactness
- ✓Eccentricity
- ✓RMS (Rotational Mass Symmetry)
- ✓SOL (Slenderness of Leaves)
- ✓Color index
- ✓ Leaf development tracking
- ✓Plant biomass
- ✓ RLGR
- ✓…

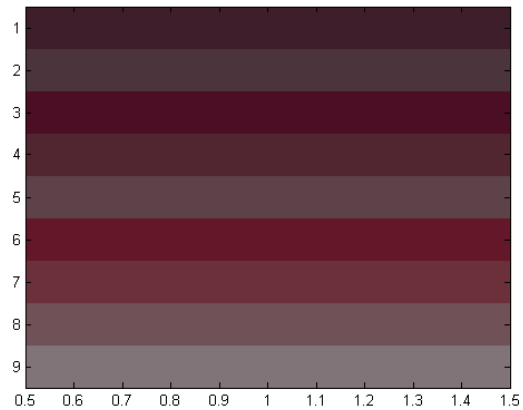
Morphological and color analysis with RGB imaging

Color index analysis





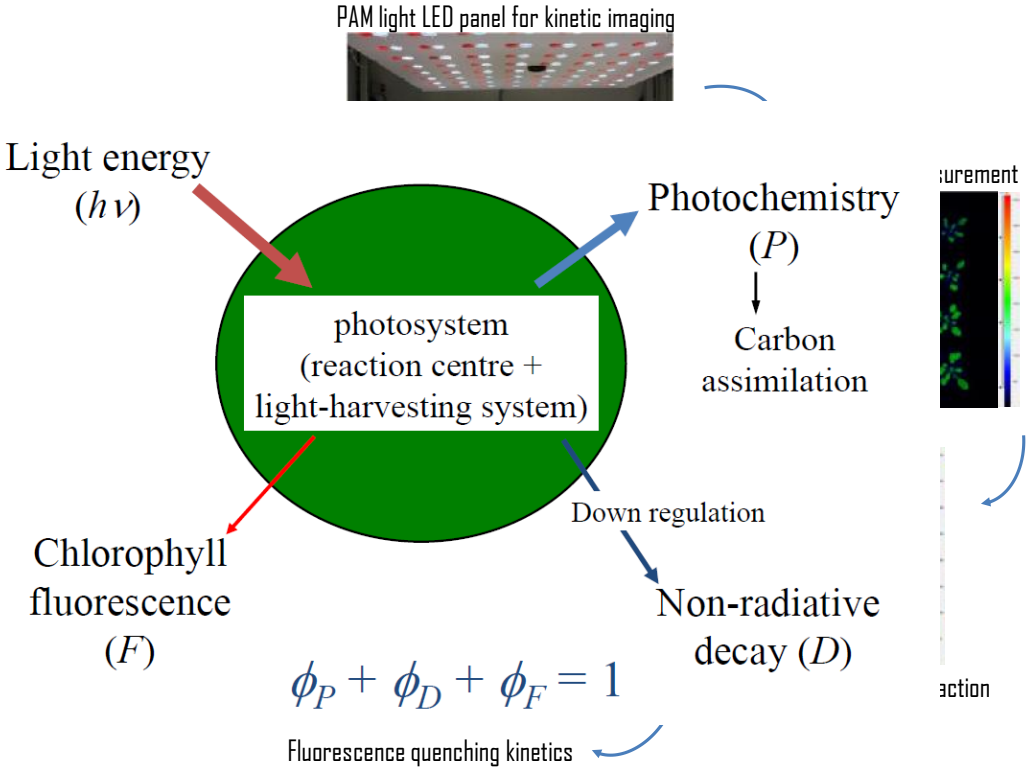




Color index analysis of 3 week old lettuce plants

Color index analysis of strawberry and raspberry fruits

Photosynthetic performance and kinetic chlorophyll fluorescence imaging



Applications

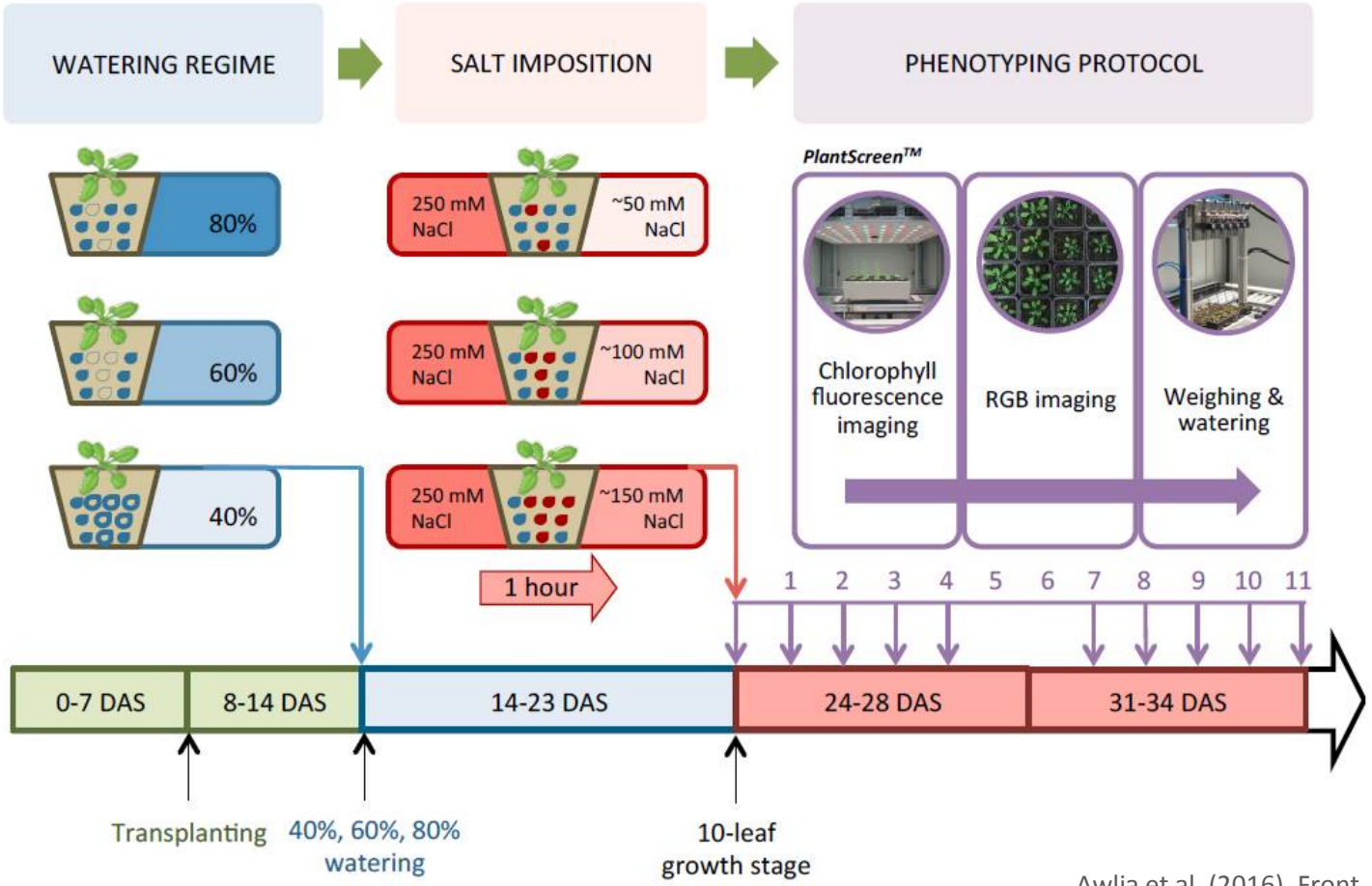
Photosynthetic status, quantum yield, ETR, non-photochemical quenching, …

Generally assesed parametres:

Measured parameters : F_O, F_M, F_V, $F_{O'}$, $F_{M'}$, $F_{V'}$, F_T

Calculated parameters: F_V/F_M, $F_{V'}/F_{M'}$, **Φ_{PSII}, NPQ, qN, qP, Rfd,..**

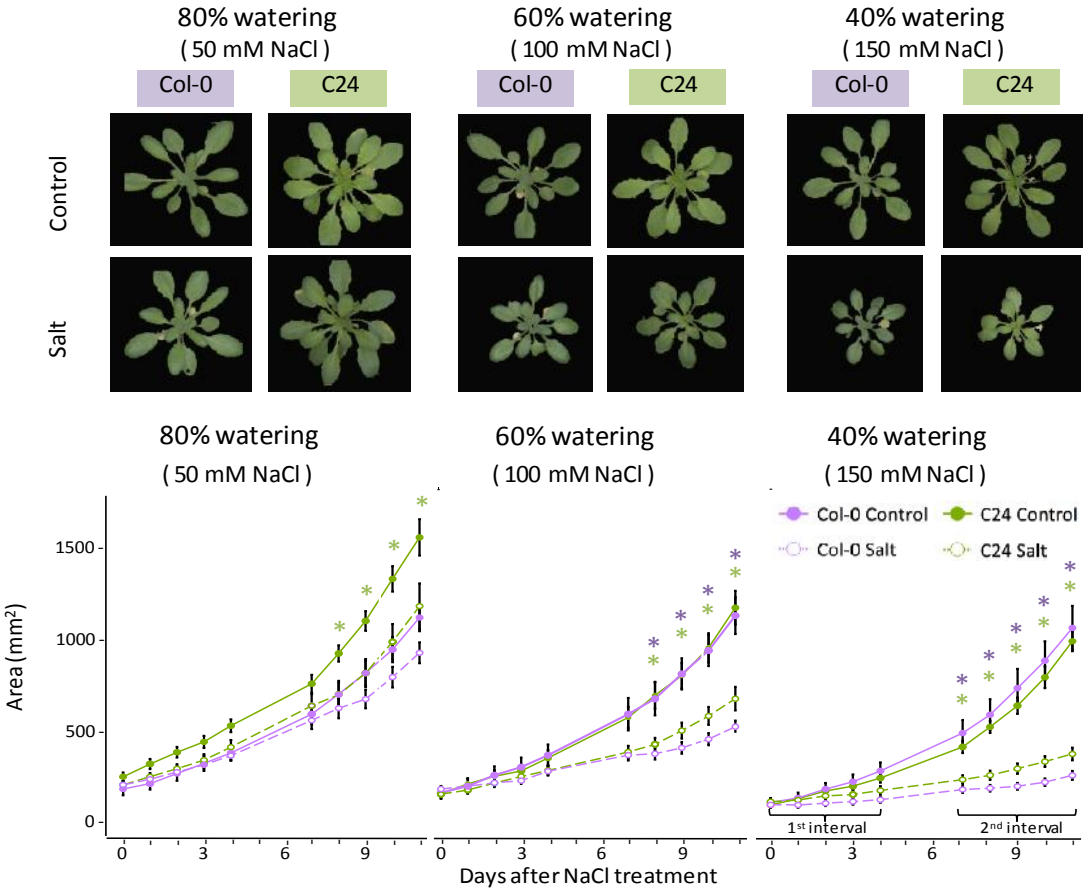
Protocol development for screening plant performance under salinity stress

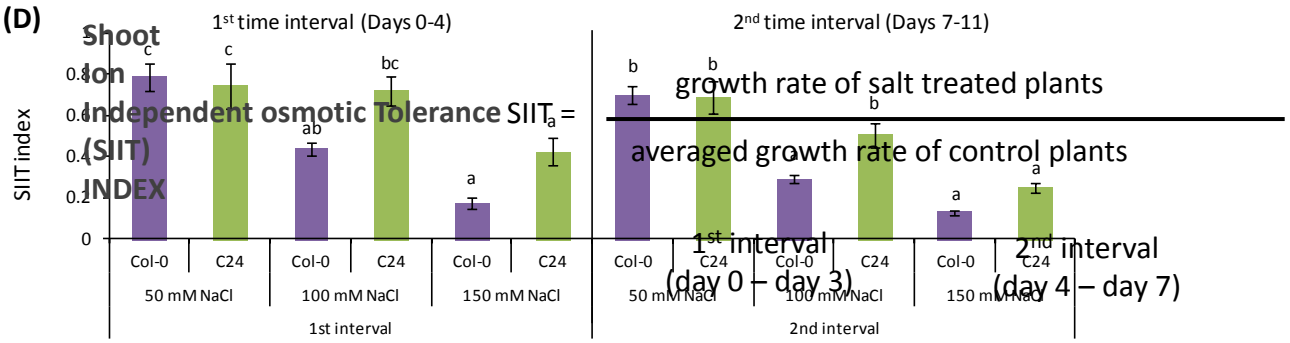


Awlia et al. (2016), Front. Plant Sci.

Salt stress application and phenotyping protocol.
Col-0 and C24 accessions were used for method development and validation.

Salt stress affects growth-related traits through time





Shoot Ion Independent osmotic Tolerance (SIIT) INDEX

$SIIT_a$ = growth rate of salt treated plants / averaged growth rate of control plants

1st interval (day 0 – day 3)

2nd interval (day 4 – day 7)

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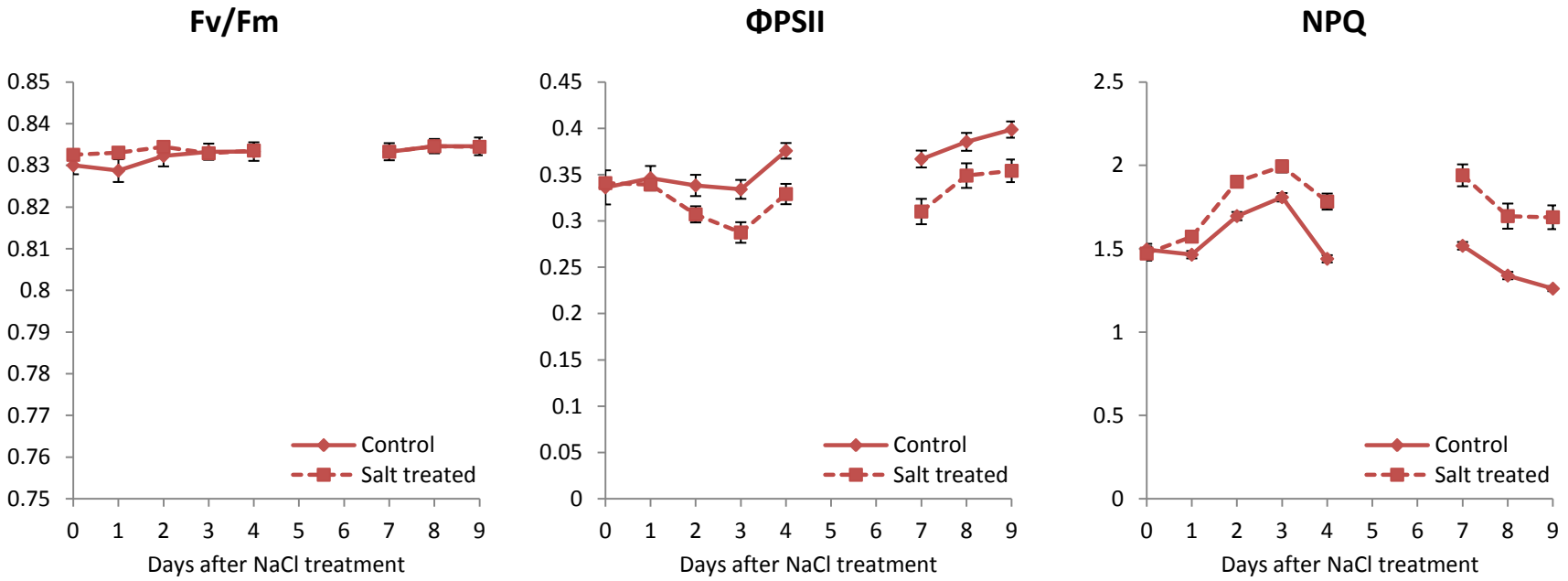
Awlia et al. (2016), Front. Plant Sci.

Light curve-derived chlorophyll fluorescence reflects early salt stress responses

Col-0
60% watering regime



Photosynthetic performance is rapidly changed in salt-treated plants.

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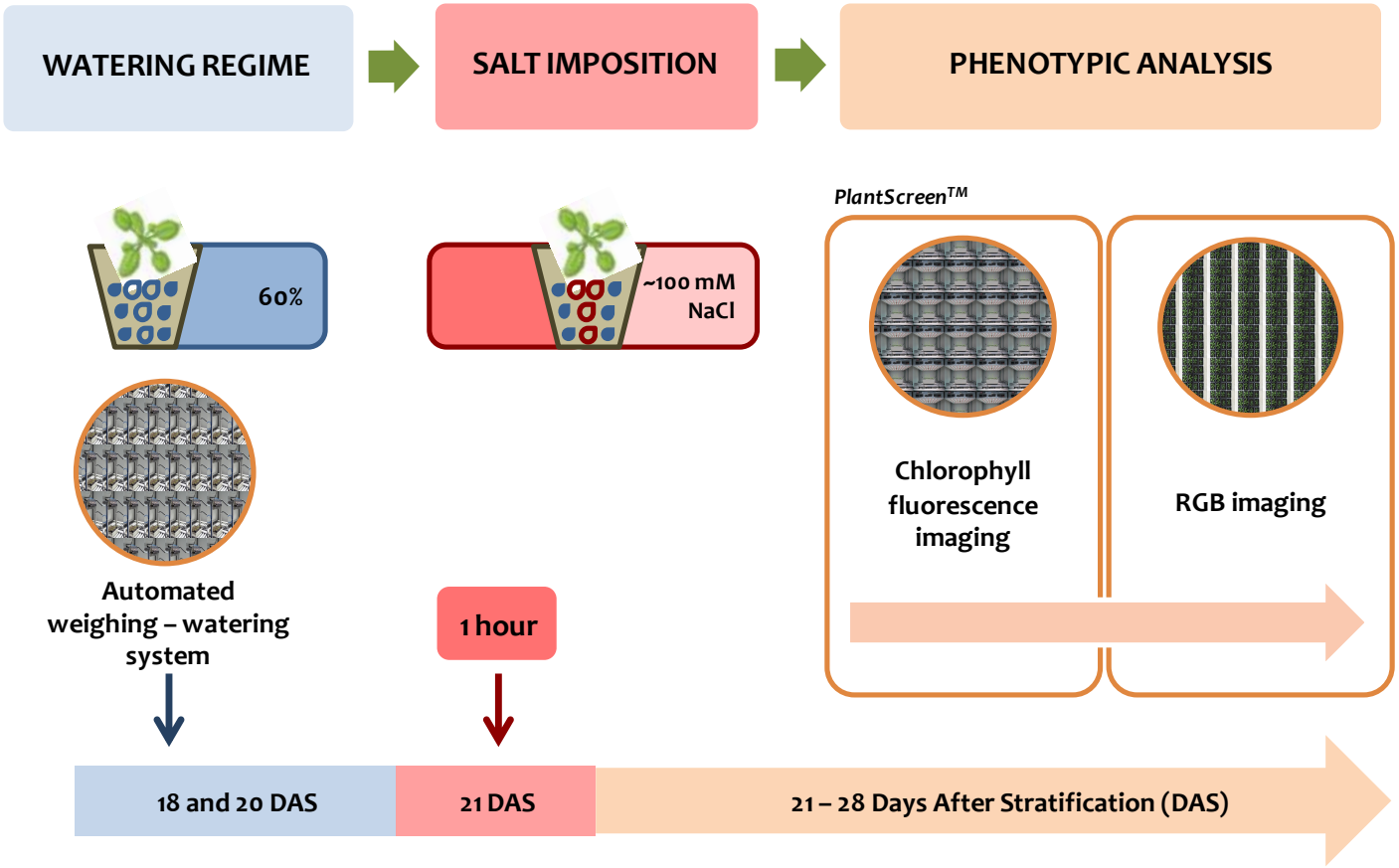
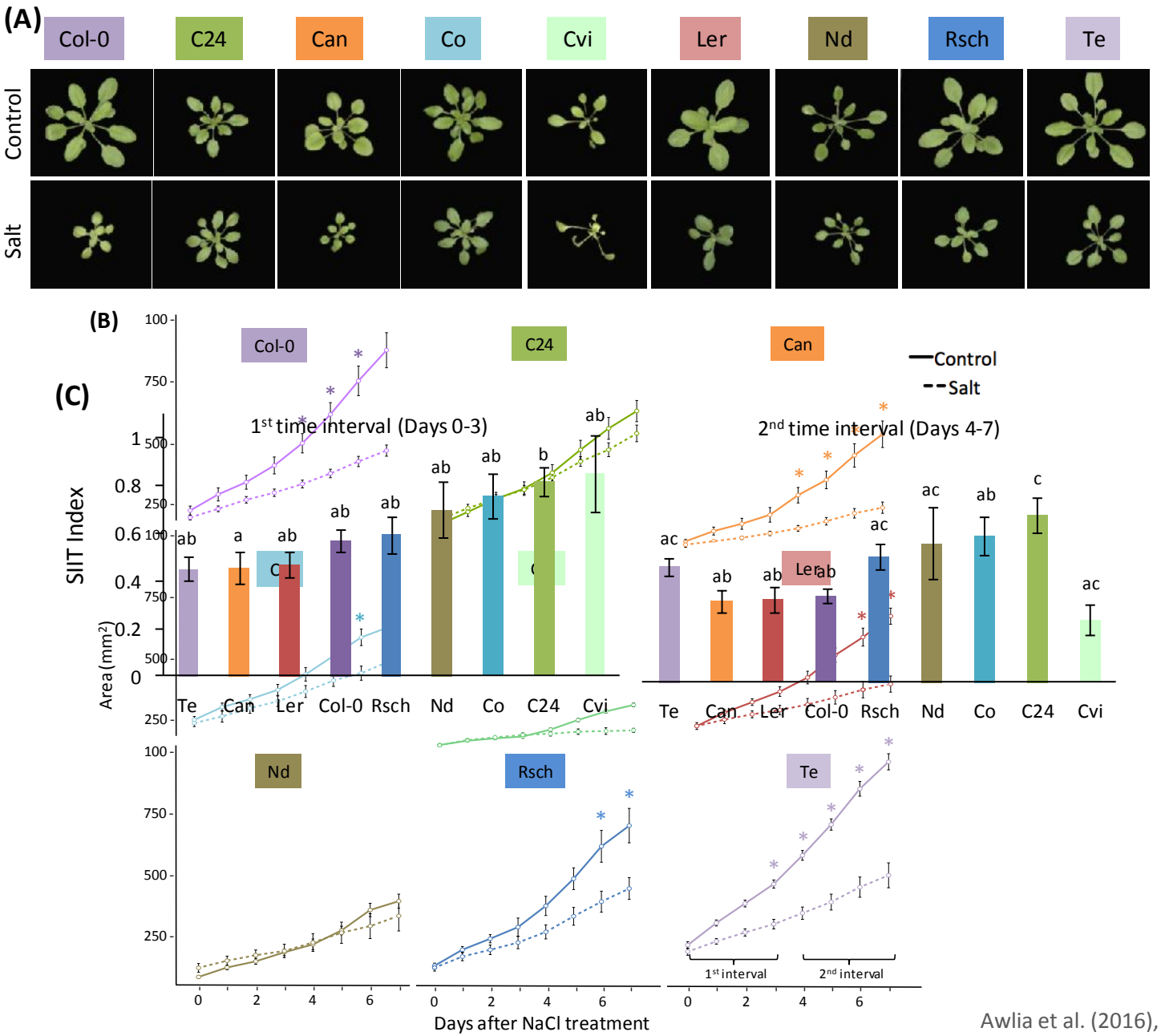
Screening method for salinity tolerance traits in Arabidopsis



modified from Awlia M. et al., 2016, Front. Plant Sci.

Natural variation in the early and late responses to salt stress



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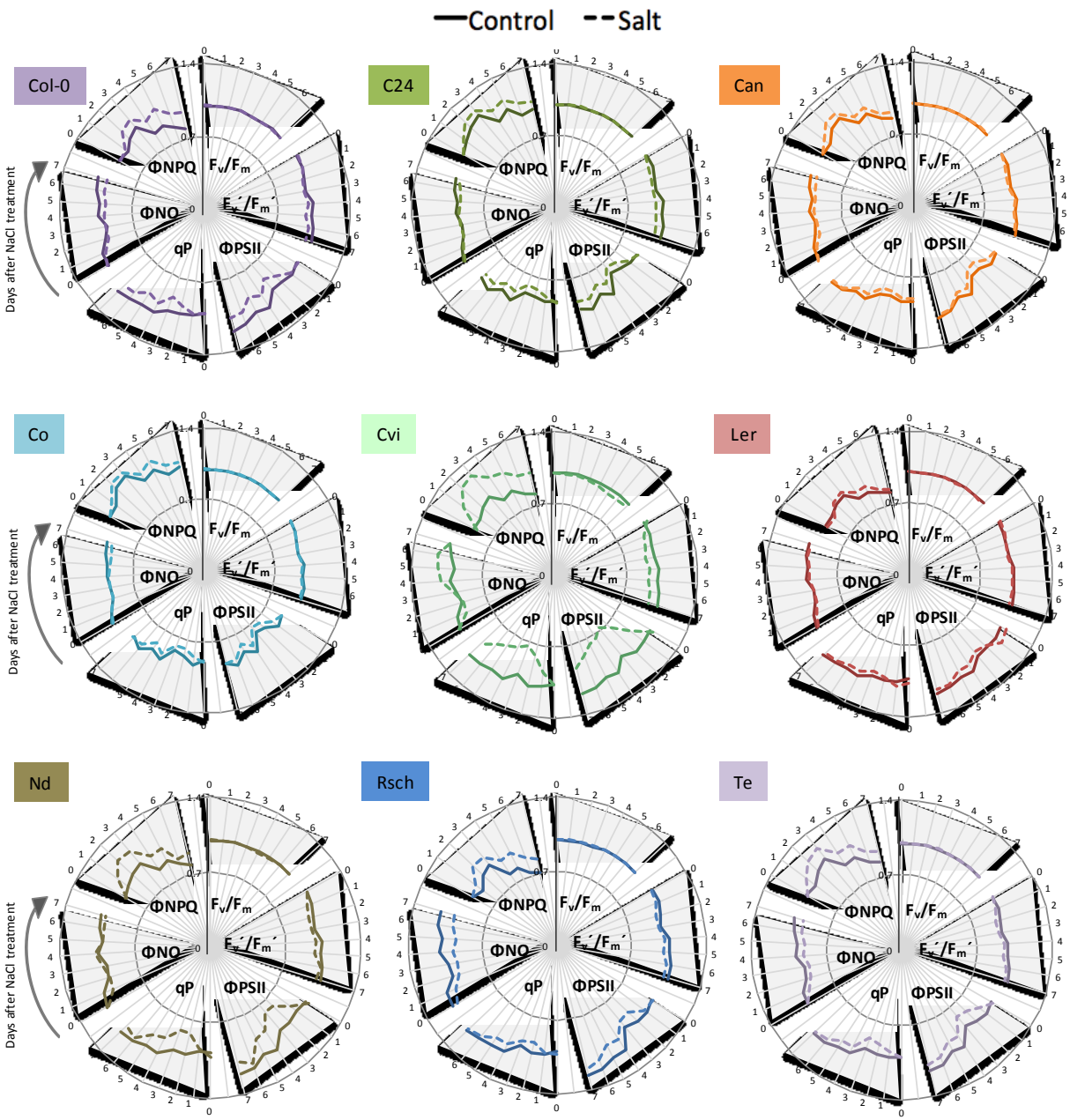
Awlia et al. (2016), Front. Plant Sci.

Natural variation in the salt-induced chlorophyll fluorescence changes



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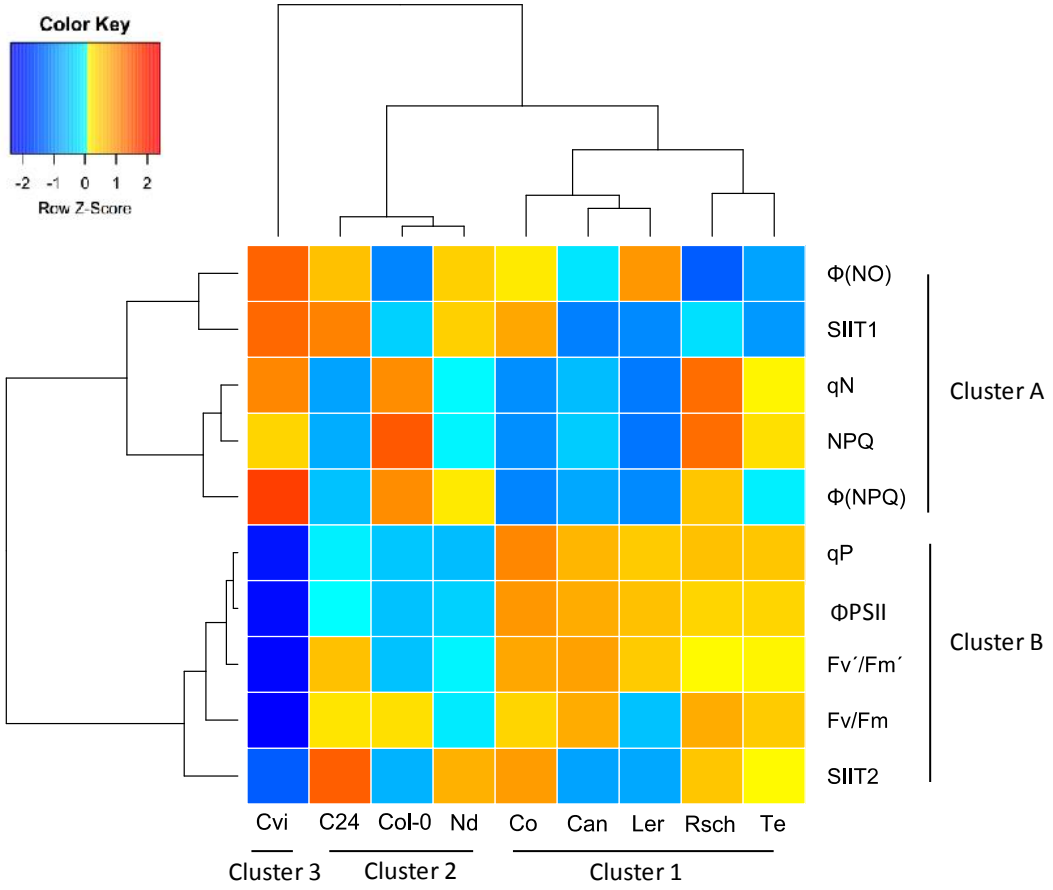
Awlia et al. (2016), Front. Plant Sci.

Non-photochemical protective processes are associated with early salt-induced growth reduction



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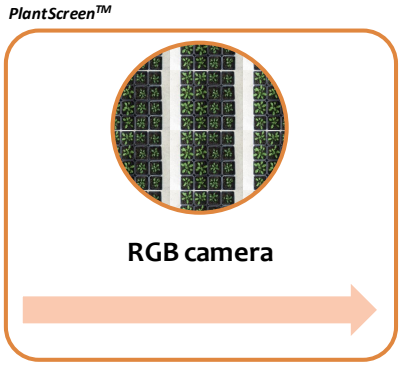
Awlia et al. (2016), Front. Plant Sci.

Conclusions

- phenotyping multiple quantitative traits in one experimental setup can provide new insights into the dynamics of plant responses to stress

Impact of salinity stress on

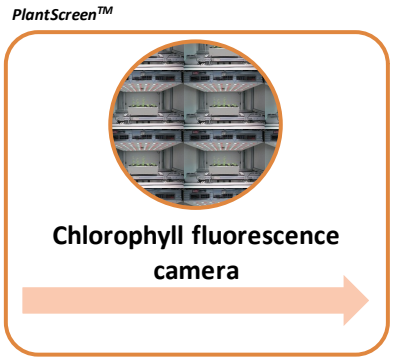
- plant growth
- leaf color pattern
- plant morphology



ROSETTE AREA

- ✓ Growth rate
- ✓ SIIT index
- ✓ Leaf greenness

- plant photosynthetic performance



CHLOROPHYLL FLUORESCENCE PARAMETERS

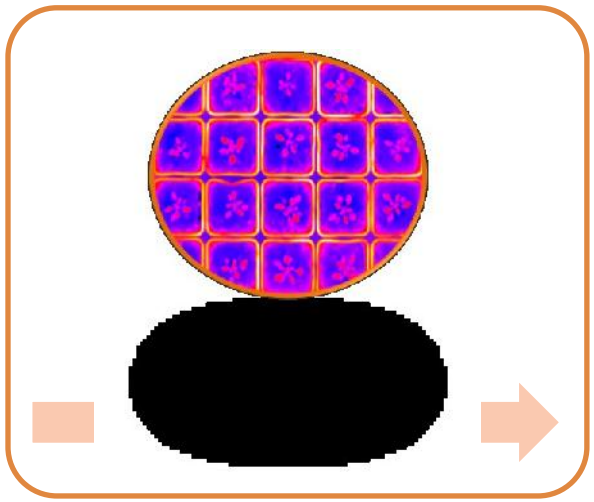
- ✓ NPQ
- ✓ qP
- ✓ Fq´/Fm´
- X Fv/Fm

- Identified a novel set of phenotypes that can serve as markers for early salt stress responses
- Natural variation in the early and late responses to salt stress
- Integrative approach allows simultaneous analysis of different phenotypic traits reflecting early salt stress responses and responses describing plant performance at later stage of salt exposure

Outlook and next steps

Thermal Imaging

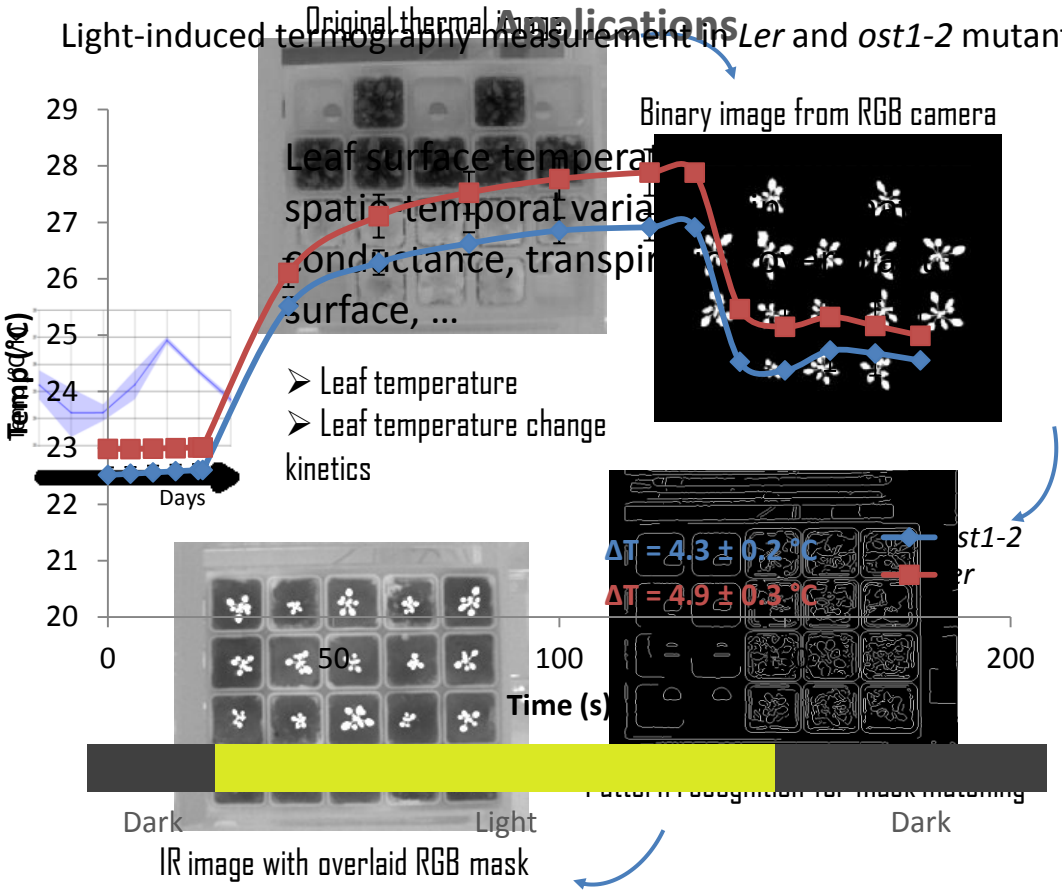
PlantScreen™



Leaf surface temperature

Applications

Light-induced termography measurement in *Ler* and *ost1-2* mutant



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Outlook

Hyperspectral Imaging

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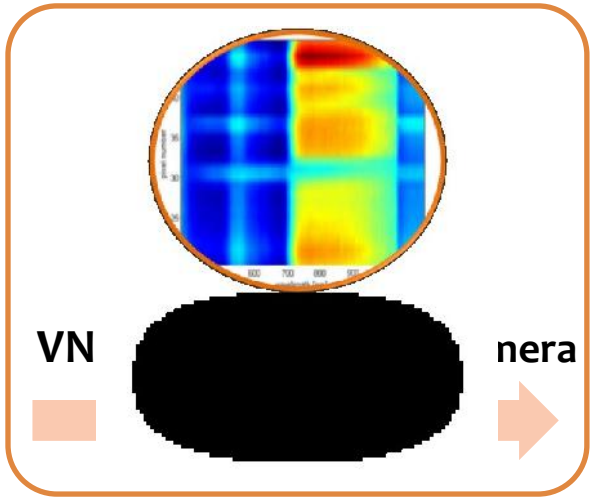
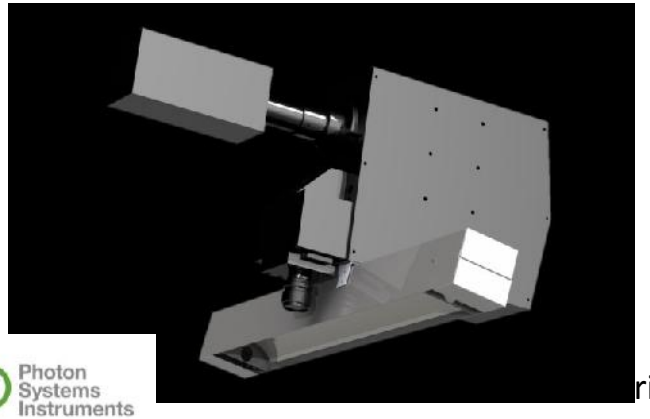


Chemical sensing, pigment classification



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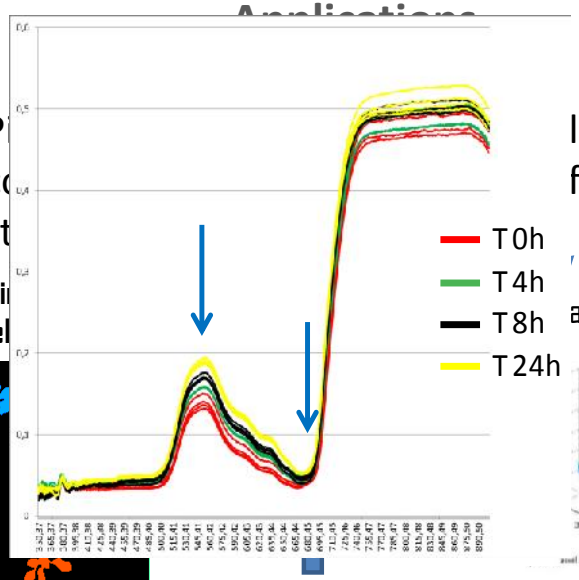
High light stress in 24-d old Arabidopsis plants



Vegetation i
each pixel

l
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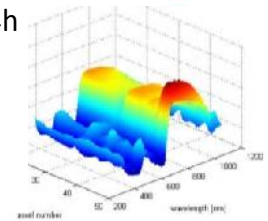
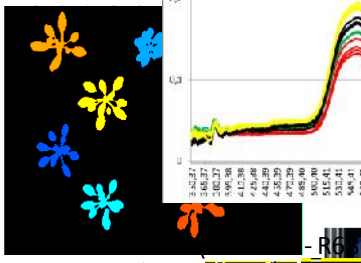
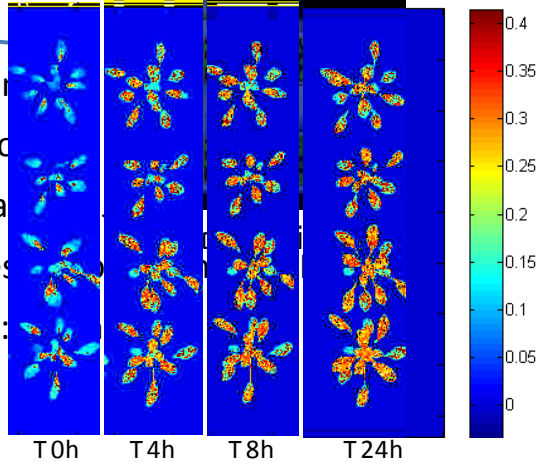
ale reflectance profile





- R680nm)

•Spectral ra
•Spatial reso
•Spectral ba
•Spectral res
•Dispersion:



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Thank you for your attention!