Introduction to Abiotic Stresses

Part 2

Effect on crop plants

Plant response

Breeding strategies

Drought

Salt

Heat

Flooding

Cold

Heavy metal

Dr. Shailendra Sharma

Genetics and Plant Breeding

EFFECTS OF DROUGHT ON CROP PLANTS

1. Crop growth and yield

2. Water relations

3. Nutrient relations

4. Photosynthesis

   Reduction in photosynthesis, decrease in leaf expansion, impaired photosynthetic machinery, premature leaf senescence and associated reduction in food production

   4.1. Stomatal oscillations

   4.2. Photosynthetic enzymes

   4.3. Adenosine triphosphate synthesis

5. Assimilate partitioning

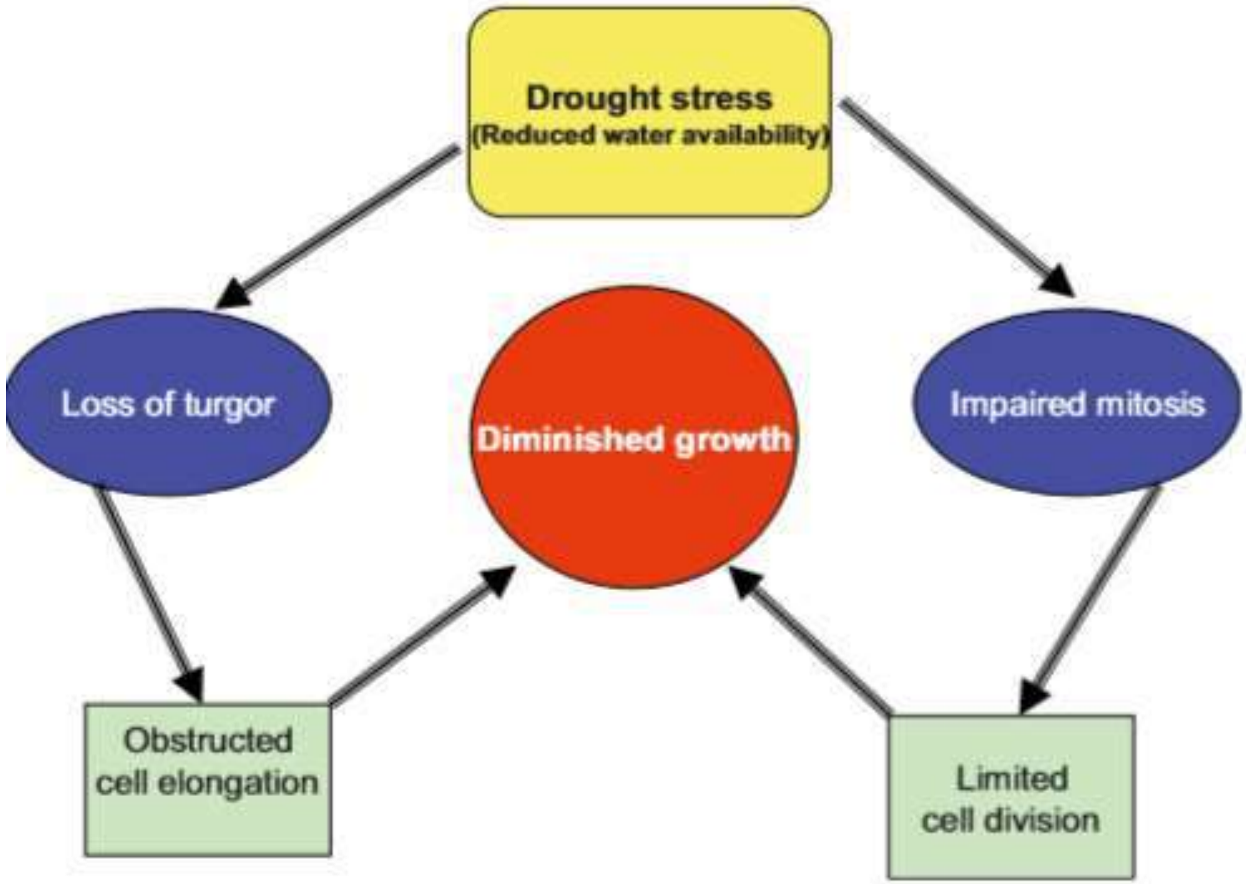
6. Respiration

7. Oxidative damage

(For detail consult paper by M. Farooq et al. (2009) Agron. Sustain. Dev. 29 (2009) 185–212

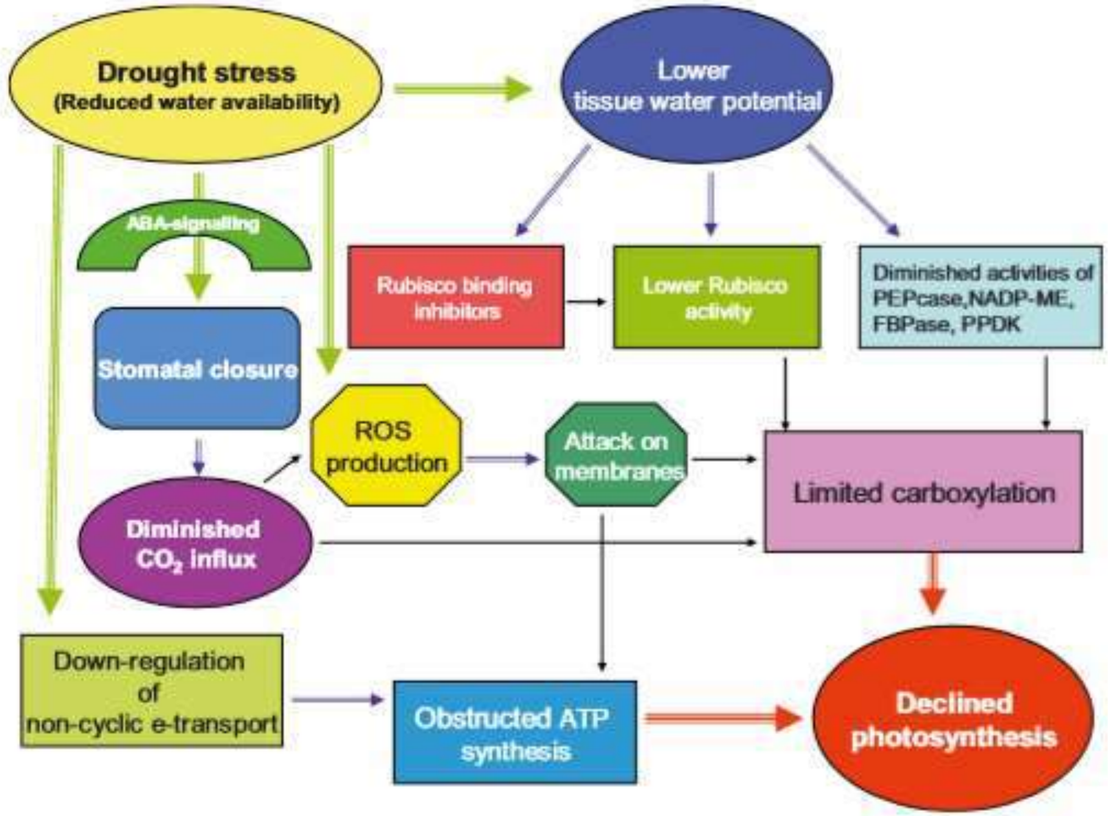
Effect of drought stress on the vegetative growth of rice cv. IR64. Both the plants were grown under well-watered conditions up to 20 days following emergence. One pot was submitted to progressive soil drying (drought stress). The afternoon before the drought, all pots were fully watered (to saturation). After draining overnight, the pots were enclosed around the stem to prevent direct soil evaporation. A small tube was inserted for re-watering pots. The decrease in soil moisture was controlled by partial re-watering of the stressed pots to avoid a quicker imposition of stress and to homogenize the development of drought stress. A well-watered control pot was maintained at the initial target weight by adding the daily water loss back to the pot. This figure shows the plants 20 days after imposition of drought stress.

(For detail consult paper by M. Farooq et al. (2009) Agron. Sustain. Dev. 29 (2009) 185–212



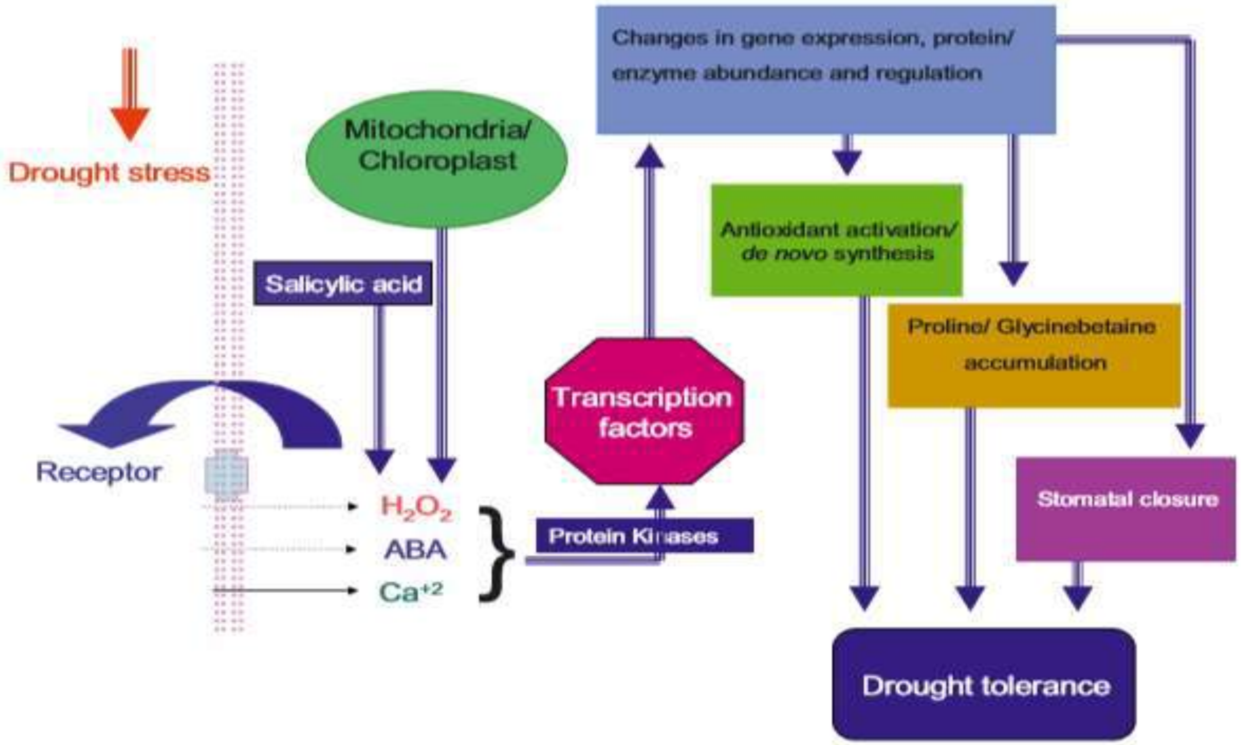
Description of possible mechanisms of growth reduction under drought stress. Under drought stress conditions, cell elongation in higher plants is inhibited by reduced turgor pressure. Reduced water uptake results in a decrease in tissue water contents. As a result, turgor is lost. Likewise, drought stress also trims down the photo assimilation and metabolites required for cell division. As a consequence, impaired mitosis, cell elongation and expansion result in reduced growth.

(For detail consult paper by M. Farooq et al. (2009) Agron. Sustain. Dev. 29 (2009) 185–212



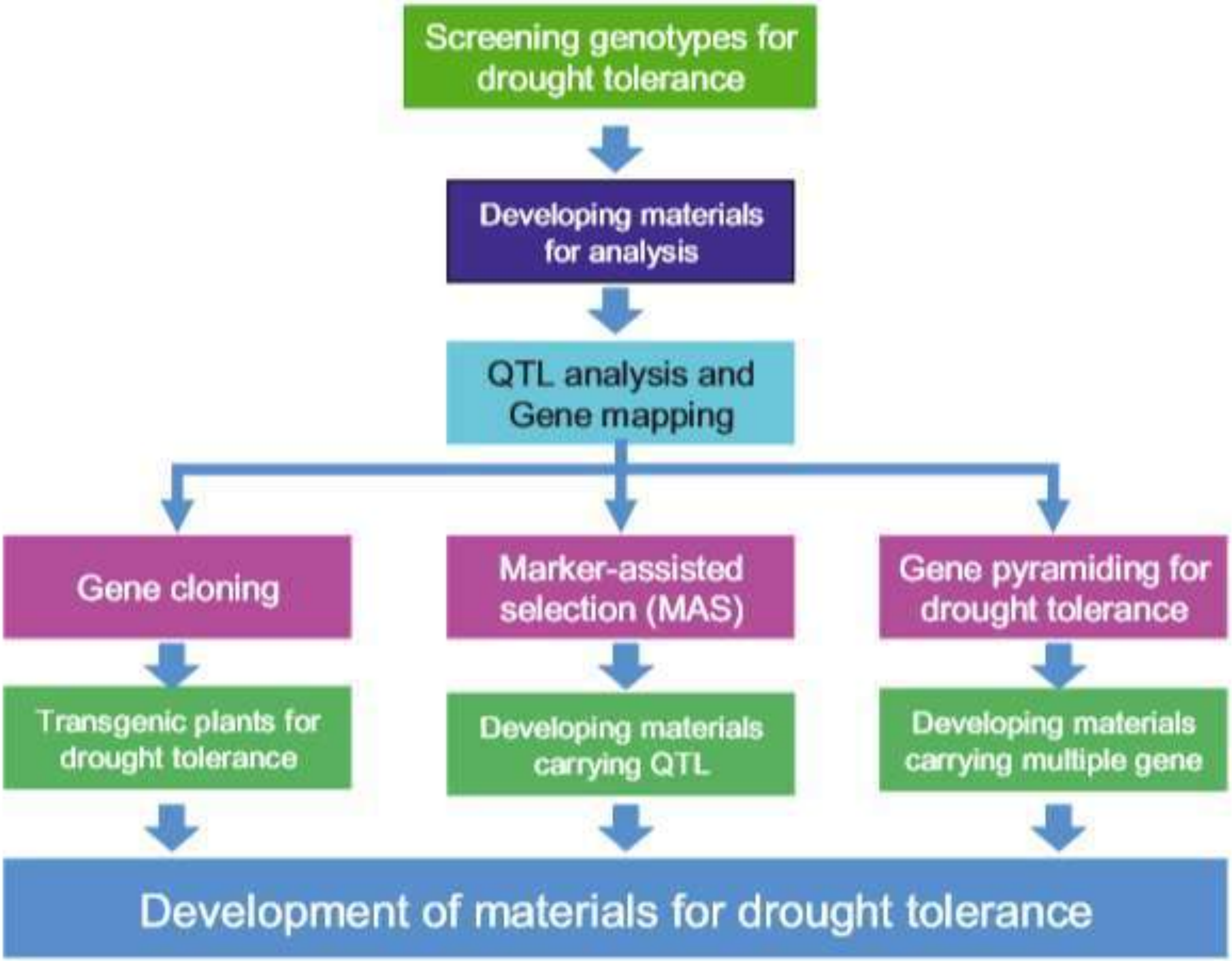
Photosynthesis under drought stress. Possible mechanisms in which photosynthesis is reduced under stress. Drought stress disturbs the balance between the production of reactive oxygen species and the antioxidant defense, causing accumulation of reactive oxygen species, which induces oxidative stress. Upon reduction in the amount of available water, plants close their stomata (plausibly via ABA signaling), which decreases the CO2 influx. Reduction in CO2 not only reduces the carboxylation directly but also directs more electrons to form reactive oxygen species. Severe drought conditions limit photosynthesis due to a decrease in the activities of ribulose-1, 5-bisphosphate carboxylase/oxygenase (Rubisco), phosphoenolpyruvate carboxylase (PEPCase), NADP-malic enzyme (NADP-ME), fructose-1, 6-bisphosphatase (FBPase) and pyruvate orthophosphate dikinase (PPDK).Reduced tissue water contents also increase the activity of Rubisco binding inhibitors. Moreover, non-cyclic electron transport is down-regulated to match the reduced requirements of NADPH production and thus reduces the ATP synthesis. ROS: reactive oxygen species.

(For detail consult paper by M. Farooq et al. (2009) Agron. Sustain. Dev. 29 (2009) 185–212



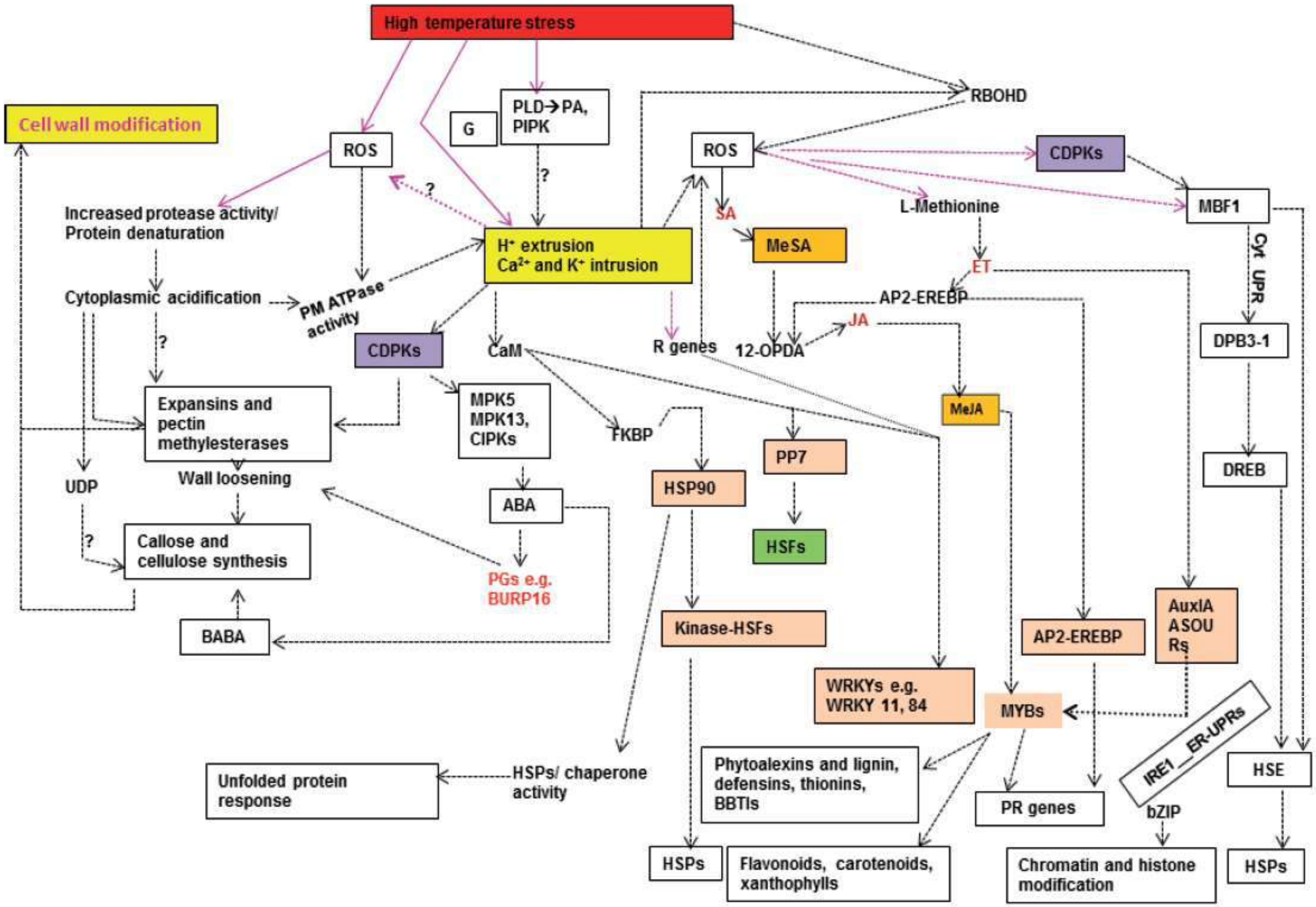
Proposed cellular events and signaling cascades in a plant cell responding to drought stress. Drought stress is perceived by an unknown mechanism, which then activates the signaling cascades, plausibly by abcissic acid (ABA), hydrogen peroxide (H_2O_2) and calcium (Ca^{+2}). These cascades then activate the synthesis of specific protein kinases which activate more downstream responses such as changes in gene expression. The response to these signaling cascades also results in changes in plant metabolism including activation and synthesis of antioxidants, synthesis and accumulation of osmoprotectants and solutes, and stomatal closure under acute drought stress.

(For detail consult paper by M. Farooq et al. (2009) Agron. Sustain. Dev. 29 (2009) 185–212



(For detail consult paper by M. Farooq et al. (2009) Agron. Sustain. Dev. 29 (2009) 185–212

Hypothetical model for high-temperature signal sensing & induction of molecular pathways leading to plant defence response



From: Chapter 9 by Geoffrey Onaga and Kerstin Wydra
Advances in Plant Tolerance to Abiotic Stresse (http://dx.doi.org/10.5772/64350)

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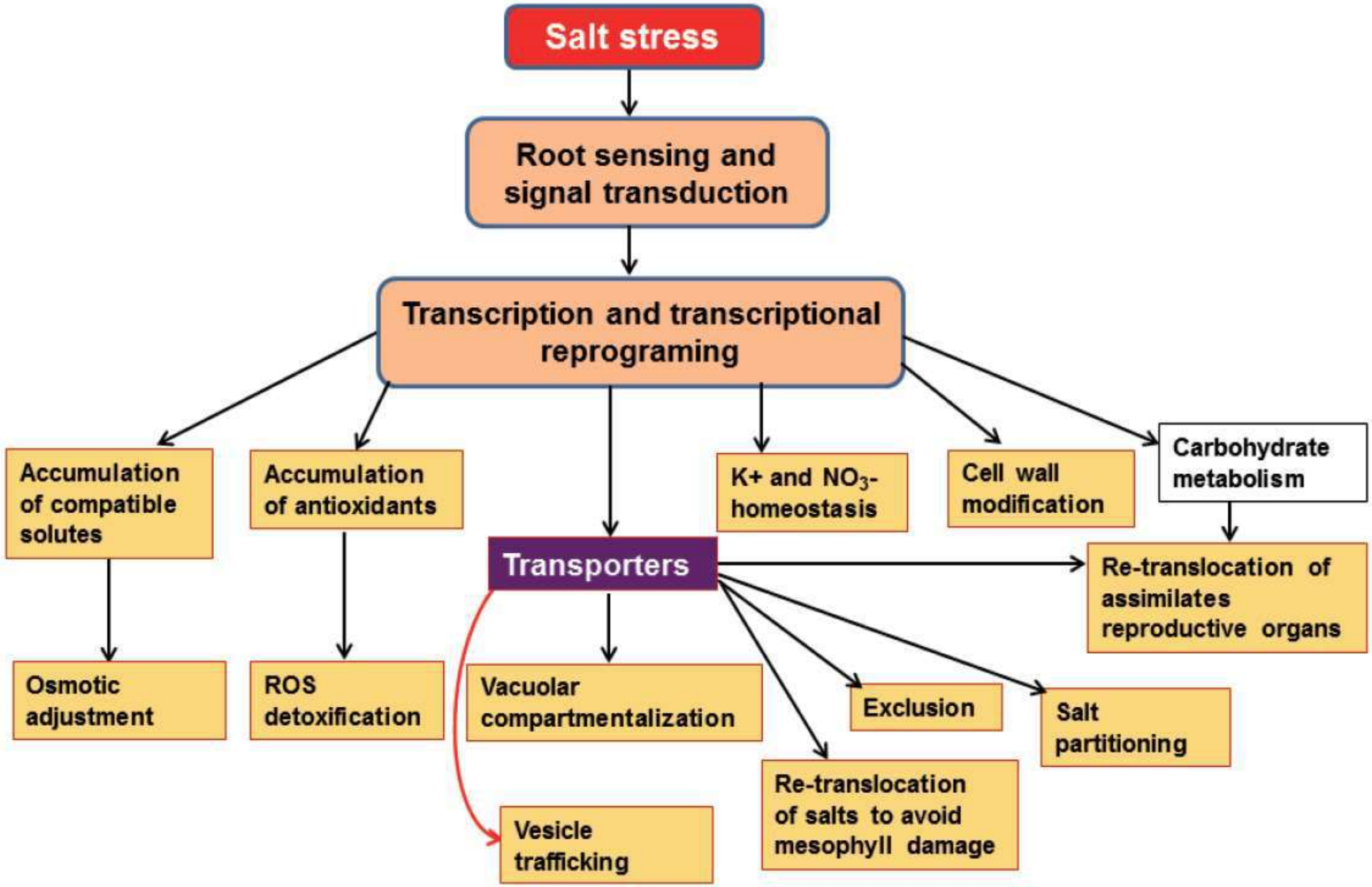
Adaptive mechanisms of salt tolerance



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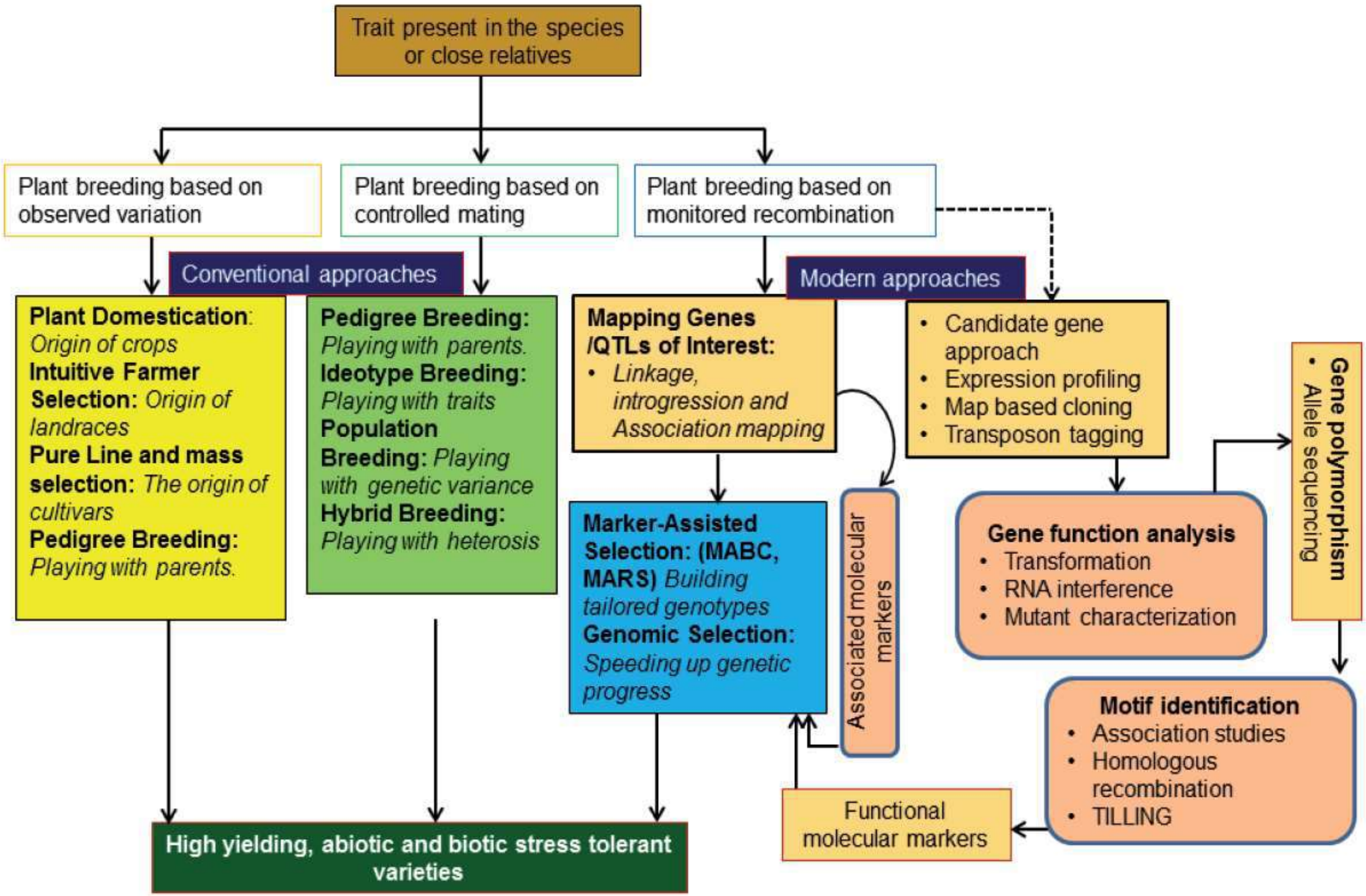
Advances in Plant Tolerance to Abiotic Stresse (http://dx.doi.org/10.5772/64350)

Overview of traditional & modern approaches in plant breeding



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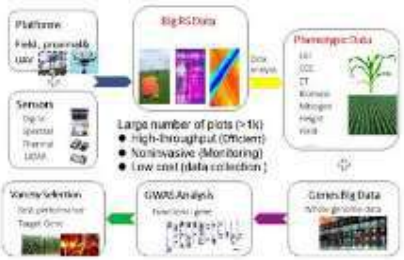


Research Topic

Advances in High-throughput Plant Phenotyping by Multi-platform Remote Sensing Technologies

Submission closed.

Overview	32 Articles	234 Authors	Impact

https://www.frontiersin.org/research-topics/6589/advances-in-high-throughput-plant-phenotyping-by-multi-platform-remote-sensing-technologies#articles

METHODS ARTICLE

Front. Plant Sci., 27 November 2017 | https://doi.org/10.3389/fpls.2017.02002

High-Throughput Phenotyping of Plant Height: Comparing Unmanned Aerial Vehicles and Ground LiDAR Estimates

Simon Madec[1*], Fred Baret[1], Benoît de Solan[2], Samuel Thomas[2], Dan Dutartre[3], Stéphane Jezequel[2], Matthieu Hemmerlé[3], Gallian Colombeau[1] and Alexis Comar[3]

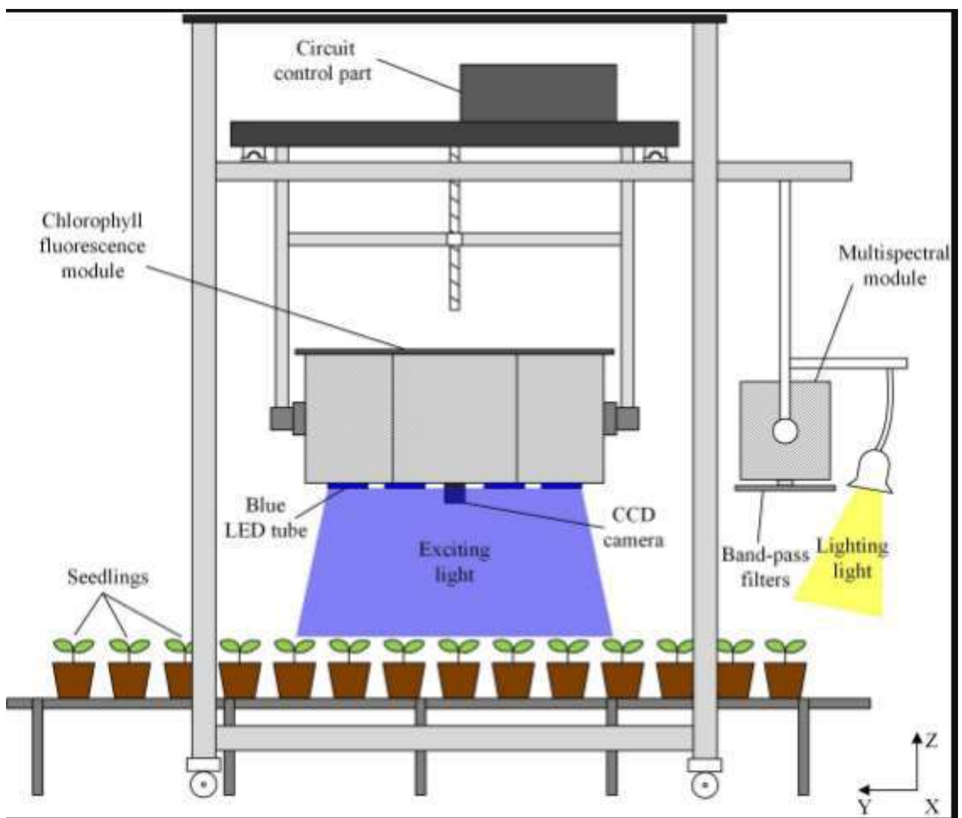
Front. Plant Sci., 27 November 2017 | https://doi.org/10.3389/fpls.2017.02002

METHODS ARTICLE
Front. Plant Sci., 28 March 2018 | https://doi.org/10.3389/fpls.2018.00407

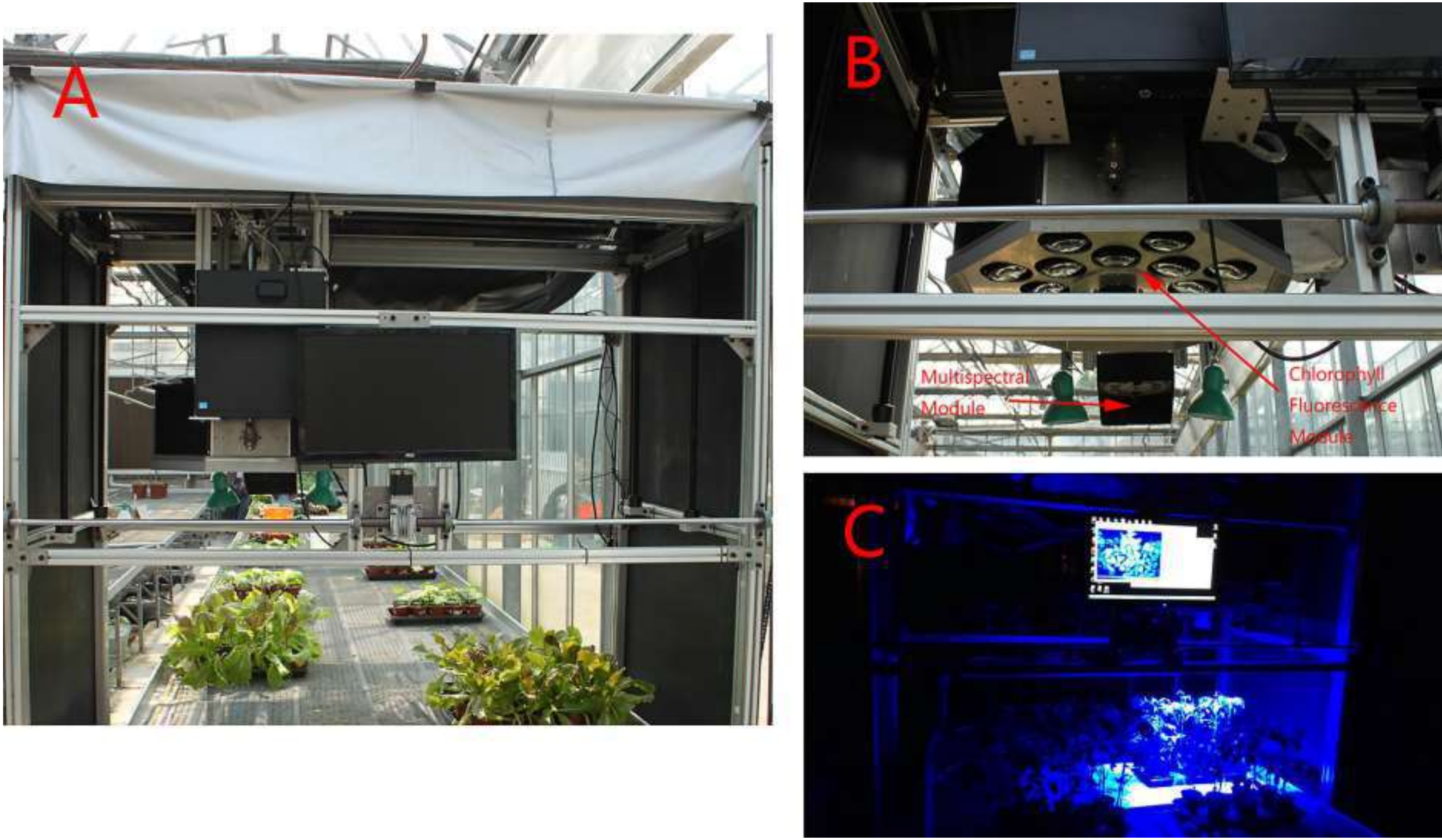
A Method of High Throughput Monitoring Crop Physiology Using Chlorophyll Fluorescence and Multispectral Imaging

Heng Wang[1], Xiangjie Qian[2], Lan Zhang[2], Sailong Xu[3], Haifeng Li[1*], Xiaojian Xia[2*], Liankui Dai[3], Liang Xu[1], Jingquan Yu[2] and Xu Liu[1]

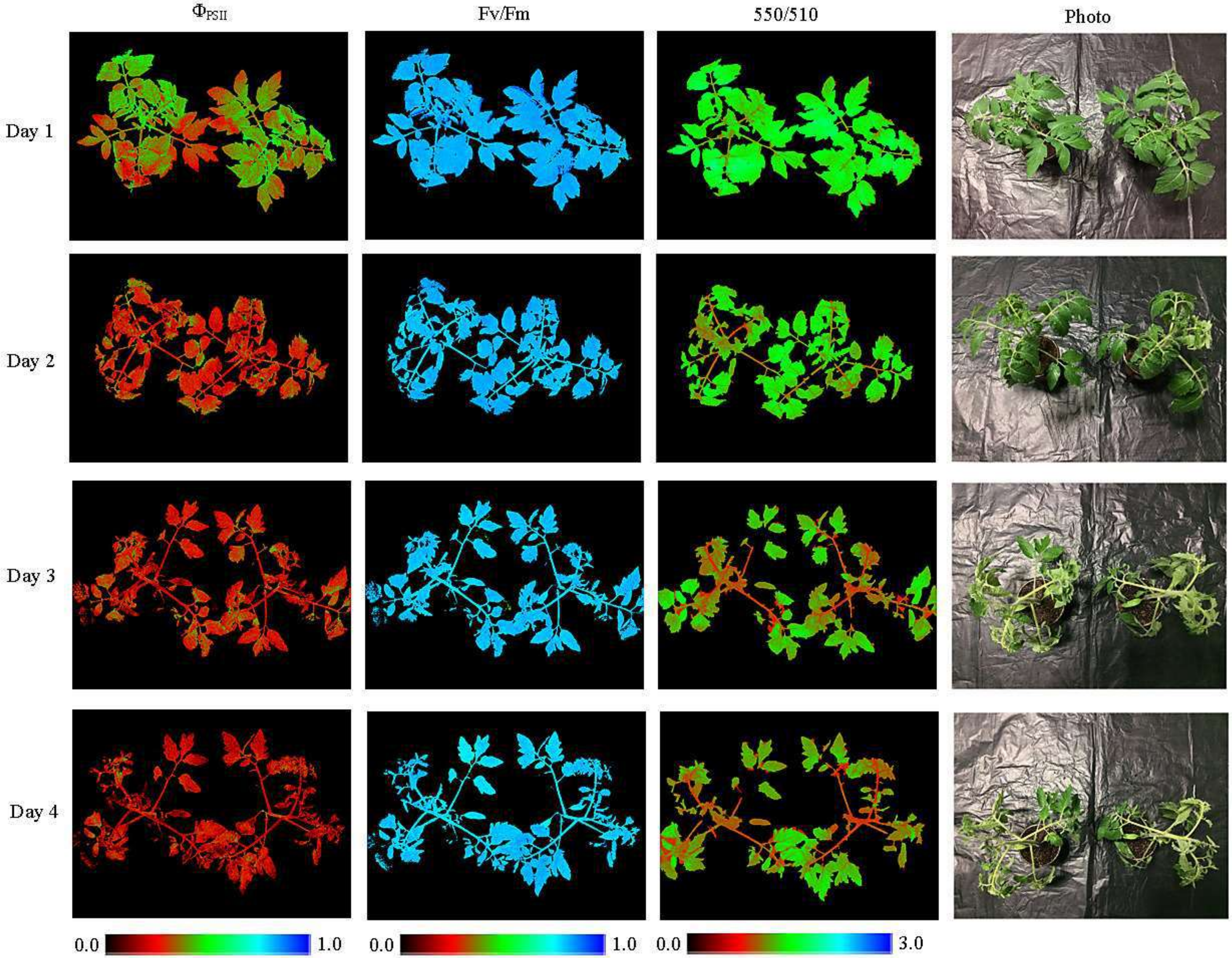
https://www.frontiersin.org/articles/10.3389/fpls.2018.00407/full



Schematic diagram of crop physiology monitoring system



A Method of High Throughput Monitoring Crop Physiology Using Chlorophyll Fluorescence and Multispectral Imaging



Φ_{PSII}
Fv/Fm
550/510
Photo
Day 1
Day 2
Day 3
Day 4
0.0
1.0
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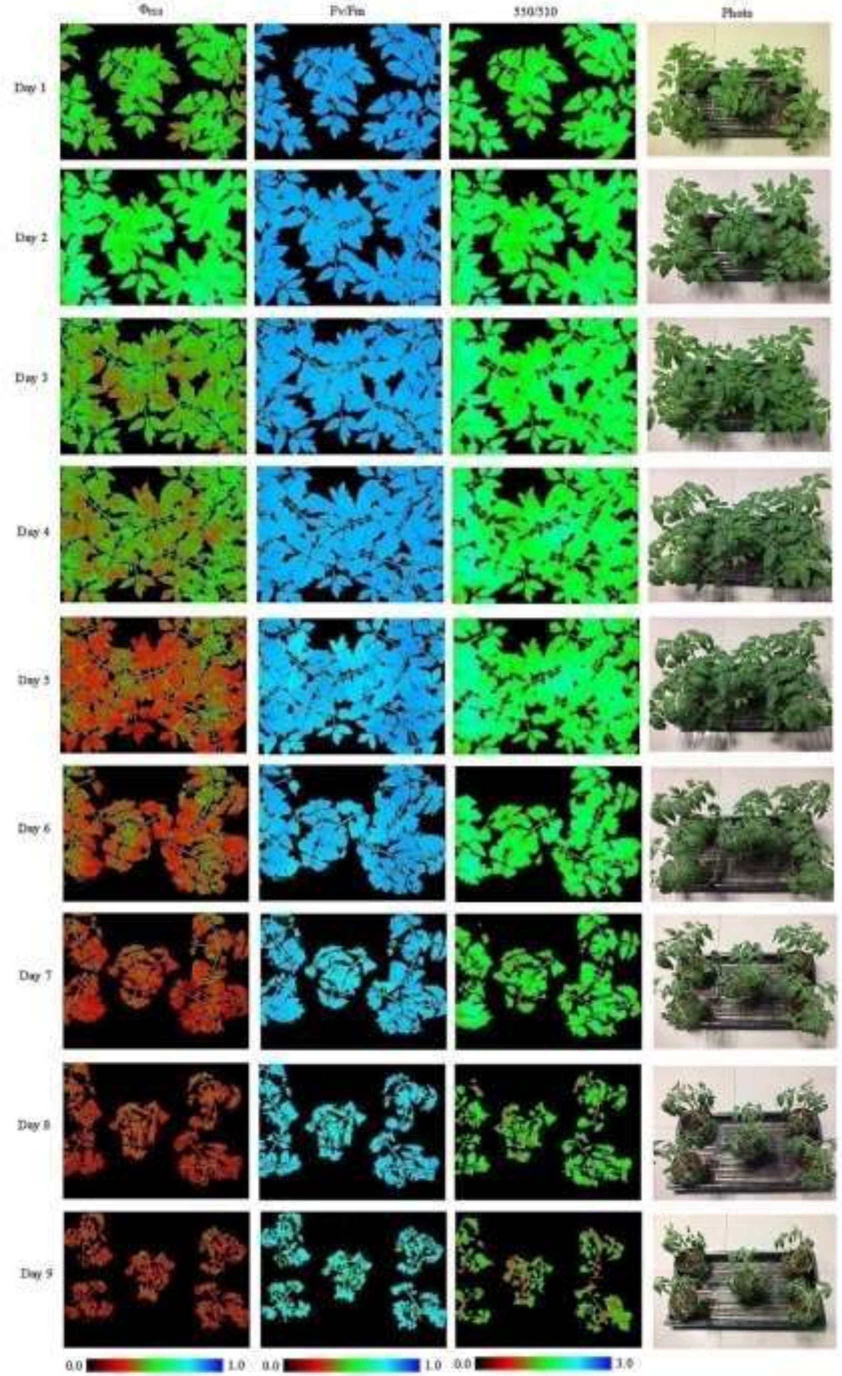

ΦPSII
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Day 1
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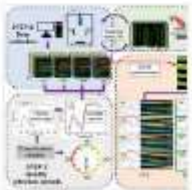


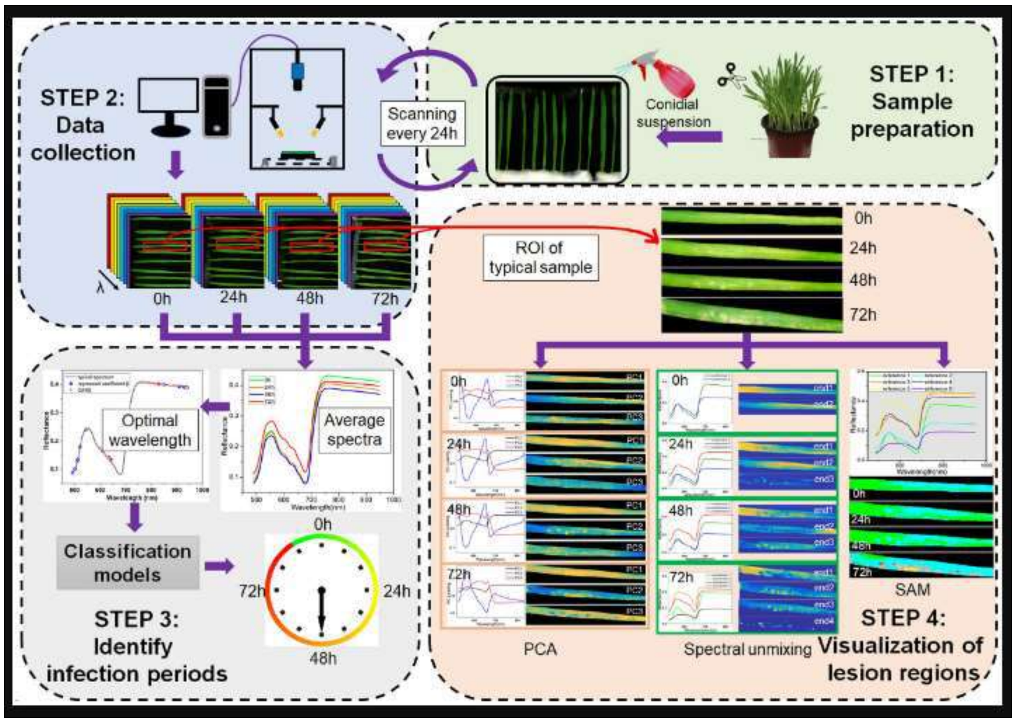
Early Detection of Magnaporthe oryzae-Infected Barley Leaves and Lesion Visualization Based on Hyperspectral Imaging

Rui-Qing Zhou , Juan-Juan Jin, Qing-Mian Li, Zhen-Zhu Su , Xin-Jie Yu, Yu Tang, Shao-Ming Luo, Yong He and Xiao-Li Li

Original Research Early detection of foliar diseases is vital to the management of plant disease, since these pathogens hinder crop productivity worldwide. This research applied hyperspectral imaging (HSI) technology to early detection of Magnaporthe oryzae-infected ...

Published on 15 January 2019
Front. Plant Sci. doi: 10.3389/fpls.2018.01962

https://www.frontiersin.org/articles/10.3389/fpls.2018.01962/full



Framework of early detection of barley leaves infected by *Magnaporthe oryzae* and visualization of lesion regions.

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