LemnaTec
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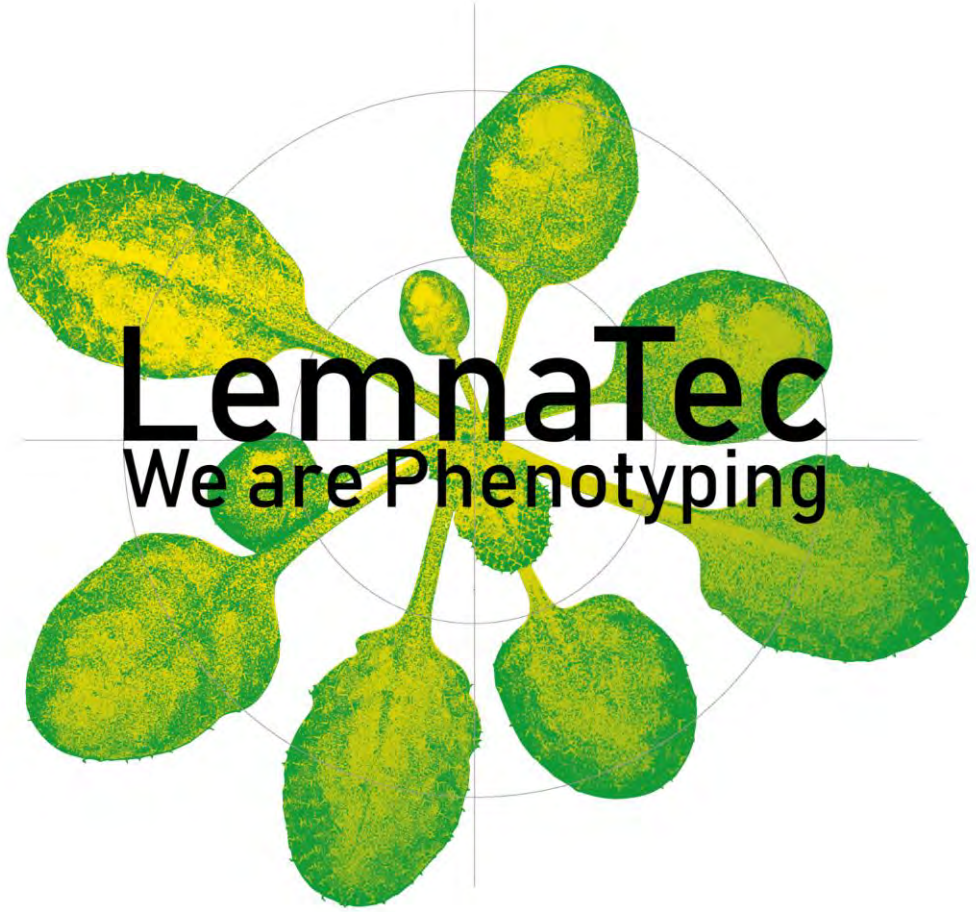
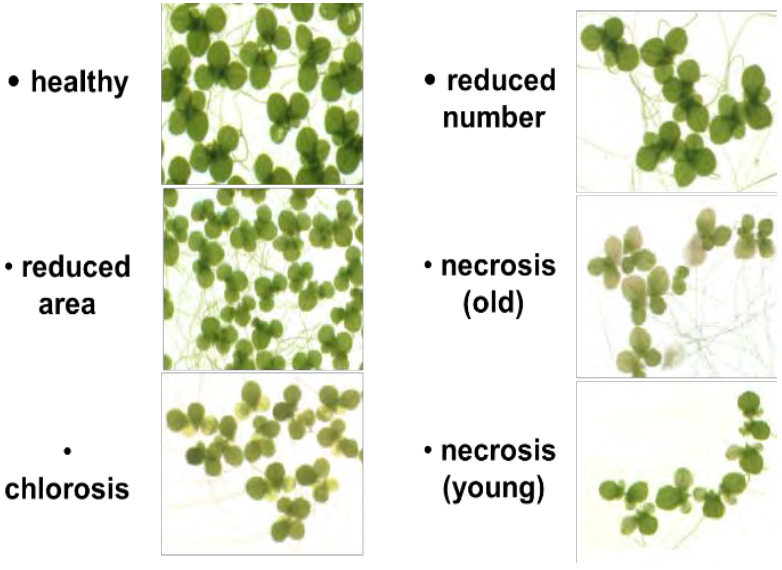


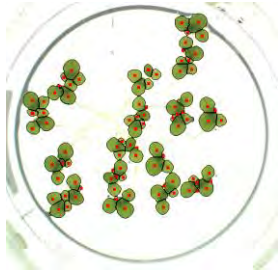
Phenotyping applications

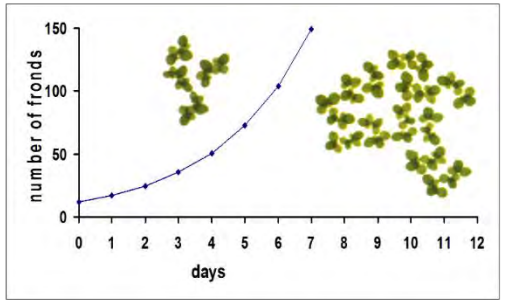
Applications in research, development, and industry

Duckweed tests for toxicology screening



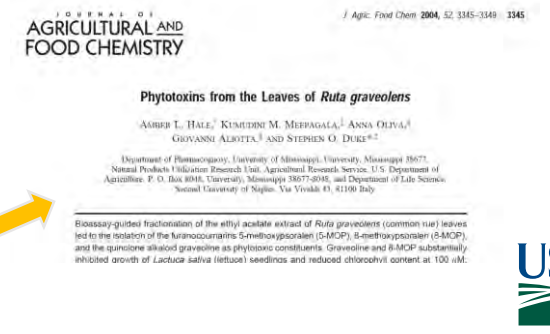
Marcus Jansen, Kevin Nagel:
LemnaTec Scanalyzer, a Versatile Tool for Duckweed Research and Testing
In: Duckweed Forum 2016.

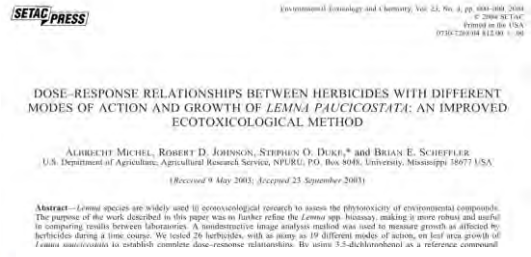




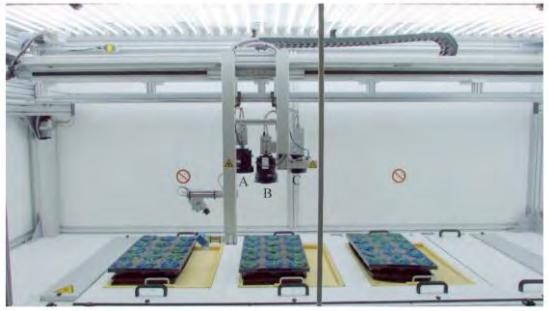
Test for toxicity to higher plants

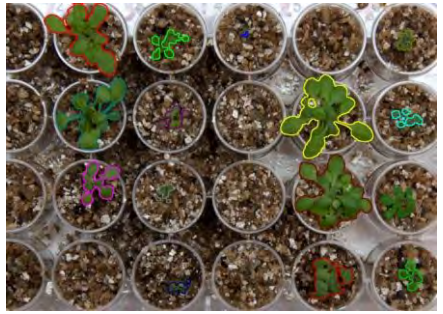
- Chemicals
- Drugs
- Food additives
- Natural compounds
- Agrochemicals and fertilisers
- Waste water





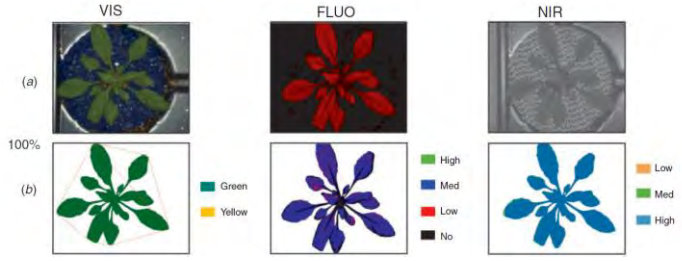
Studies on allele function or environmental factors in Arabidopsis





Lab Scanalyzer HTS – automated multi-camera platform
Visible light, infrared, fluorescence, near infrared cameras
Application examples:

- Seedlings
- Duckweed
- Insects
- Fungi
- Cells



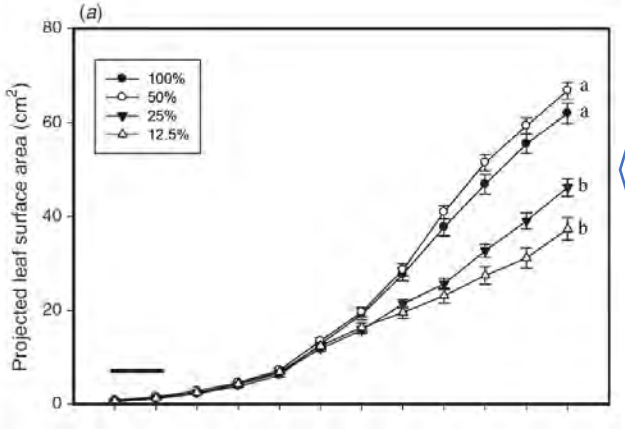
CSIRO PUBLISHING
Functional Plant Biology, 2017, **44**, 94–106
http://dx.doi.org/10.1071/FP16172

Moderate to severe water limitation differentially affects the phenome and ionome of *Arabidopsis*

Lucia M. Acosta-Gamboa[A], Suxing Liu[A], Erin Langley[A], Zachary Campbell[A], Norma Castro-Guerrero[B], David Mendoza-Cozatl[B,D] and Argelia Lorence[A,C,D]

[A]Arkansas Biosciences Institute, Arkansas State University, PO Box 639, State University, AR 72467, USA.
[B]Division of Plant Sciences, Christopher S Bond Life Sciences Center, University of Missouri, 1201 Rollins Street, Columbia, MO 65211, USA.
[C]Department of Chemistry and Physics, Arkansas State University, PO Box 429, State University, AR 72467, USA.
[D]Corresponding authors. Emails: alorence@astate.edu; mendozacozatld@missouri.edu

Abstract. Food security is currently one of the major challenges that we are facing as a species. Understanding plant responses and adaptations to limited water availability is key to maintain or improve crop yield, and this is even more



Soil water availability determined growth

New Phytologist
Research

Rapid report

BRX promotes Arabidopsis shoot growth

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Christian Hardtke
Tel: +41 21 692 4251
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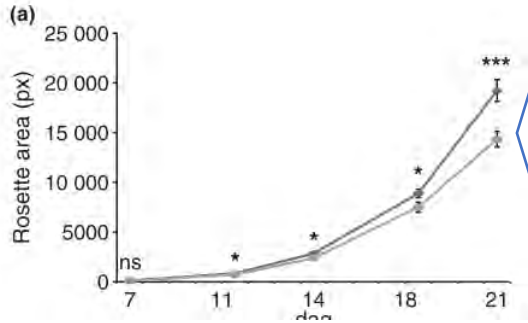
Received: *12 May 2010*
Accepted: *15 June 2010*

Julien Beuchat[1], Emanuele Scacchi[1], Danuse Tarkowska[2], Laura Ragni[1], Miroslav Strnad[2] and Christian S. Hardtke[1]
[1]Department of Plant Molecular Biology, University of Lausanne, Biophore Building, CH-1015 Lausanne, Switzerland; [2]Laboratory of Growth Regulators, Palacky University and Institute of Experimental Botany, Academy of Sciences of the Czech Republic, Slechtitelu 11, CZ-78371 Olomouc, Czech Republic

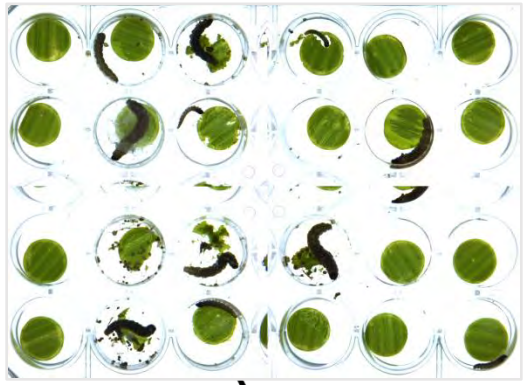


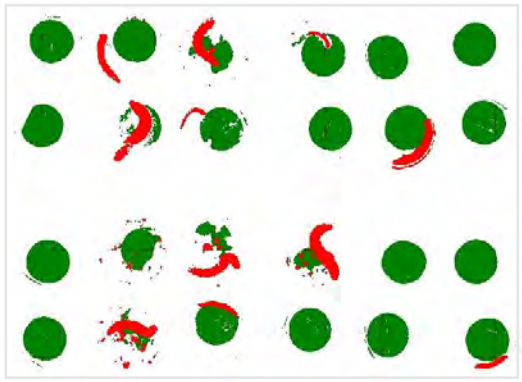
Reduced growth in loss of function line

Insect feeding and motility tests

HT-screening for leaf eating organisms

- feeding assays
- resistance screens
- organism sizes
- mortality assessment





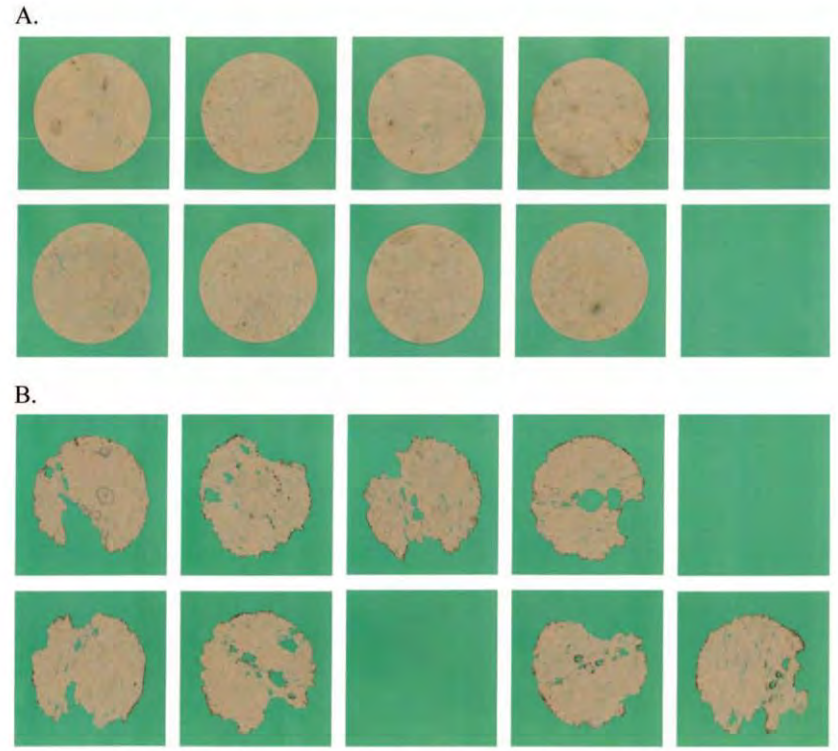


Fig. 1. (A) Scanned pictures of the brown paper towel disks with little or no feeding damage from petri dishes with termites exposed to treated soils. (B) Scanned pictures of brown paper towel disks with feeding damage from the petri dishes with termites exposed to corresponding untreated soils.

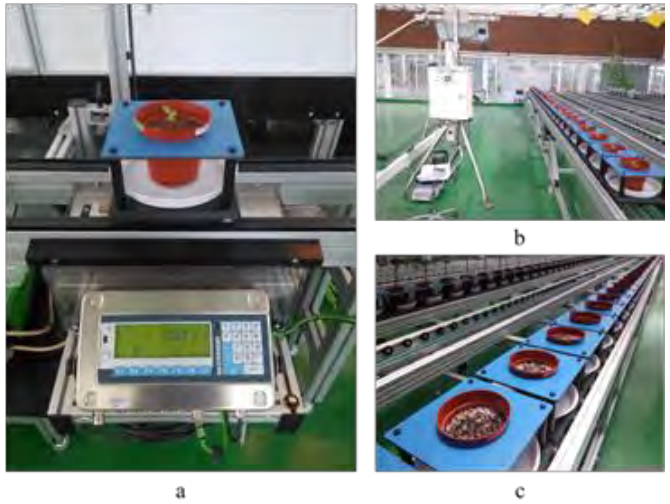
Saran, Raj K.; Ziegler, Melissa; Kudlie, Sara; Harrison, Danielle; Leva, David M.; Scherer, Clay; Coffelt, Mark A. (2014): Behavioral Effects and Tunneling Responses of Eastern Subterranean Termites (Isoptera: Rhinotermitidae) Exposed to Chlorantraniliprole-Treated Soils. In: Journal of Economic Entomology 107 (5), S. 1878–1889. DOI: 10.1603/EC11393.

Pakchoi water status phenotyping

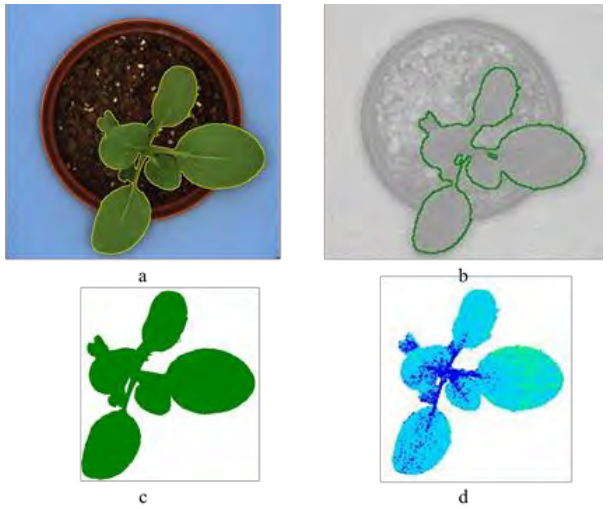
Guo, Doudou; Juan, Jiaxiang; Chang, Liying; Zhang, Jingjin; Huang, Danfeng (2017): Discrimination of plant root zone water status in greenhouse production based on phenotyping and machine learning techniques. In: Scientific reports 7 (1), S. 8303. DOI: 10.1038/s41598-017-08235-z.

Greenhouse Scanalyzer

40%/60%/80% soil water content



Visible light & NIR images



LemnaGrid

Morphology, colour, NIR intensity

Machine learning

Plant phenotypic properties as indicator for soil water content

Improving drought responses in tomato

LemnaTec
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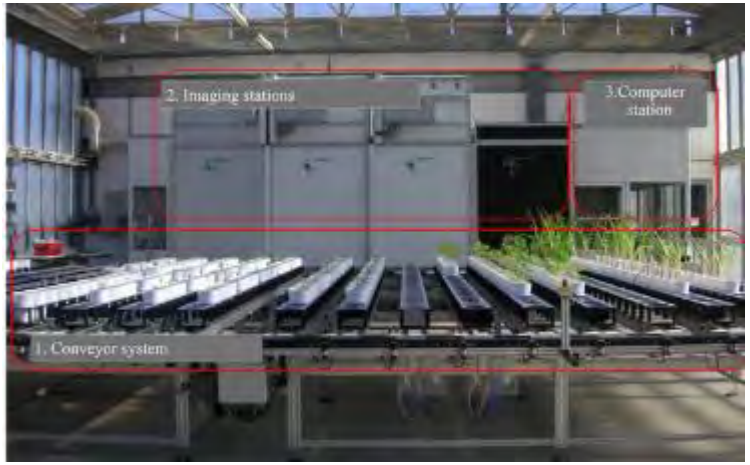
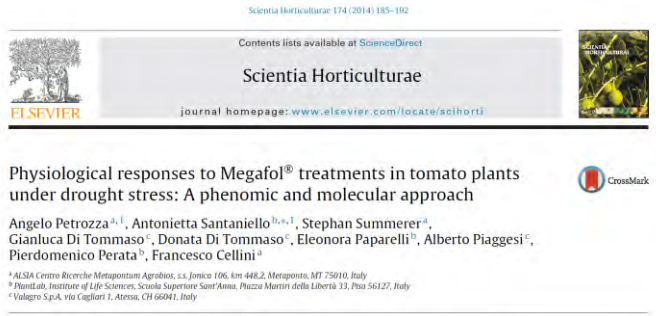
Petrozza, Angelo; Santaniello, Antonietta; Summerer, Stephan; Di Tommaso, Gianluca; Di Tommaso, Donata; Paparelli, Eleonora et al. (2014): Physiological responses to Megafol® treatments in tomato plants under drought stress: A phenomic and molecular approach. In: Scientia Horticulturae 174, S. 185–192. DOI: 10.1016/j.scienta.2014.05.023.

Tomato plants in Greenhouse Scanalyzer




Scientia Horticulturae 174 (2014) 185–192

Contents lists available at ScienceDirect

Scientia Horticulturae

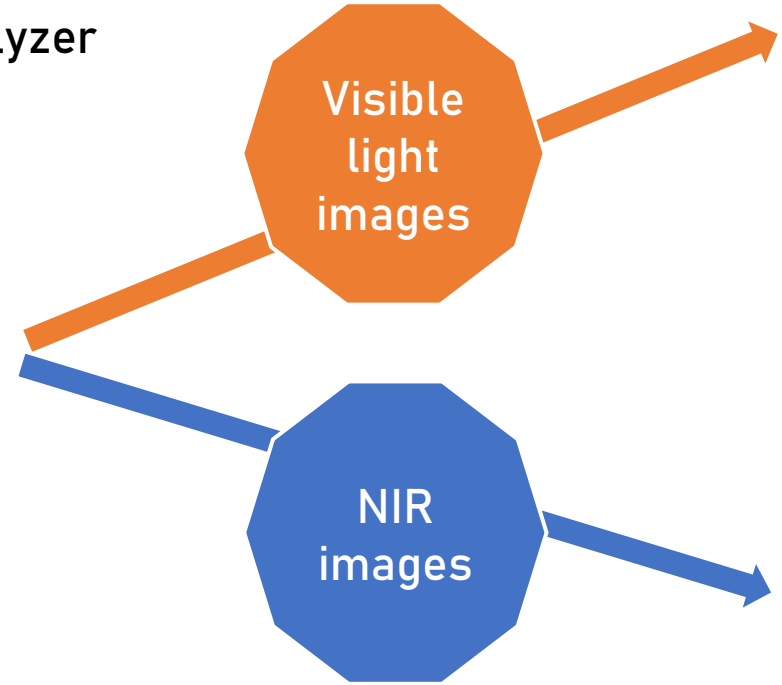
journal homepage: www.elsevier.com/locate/scihorti

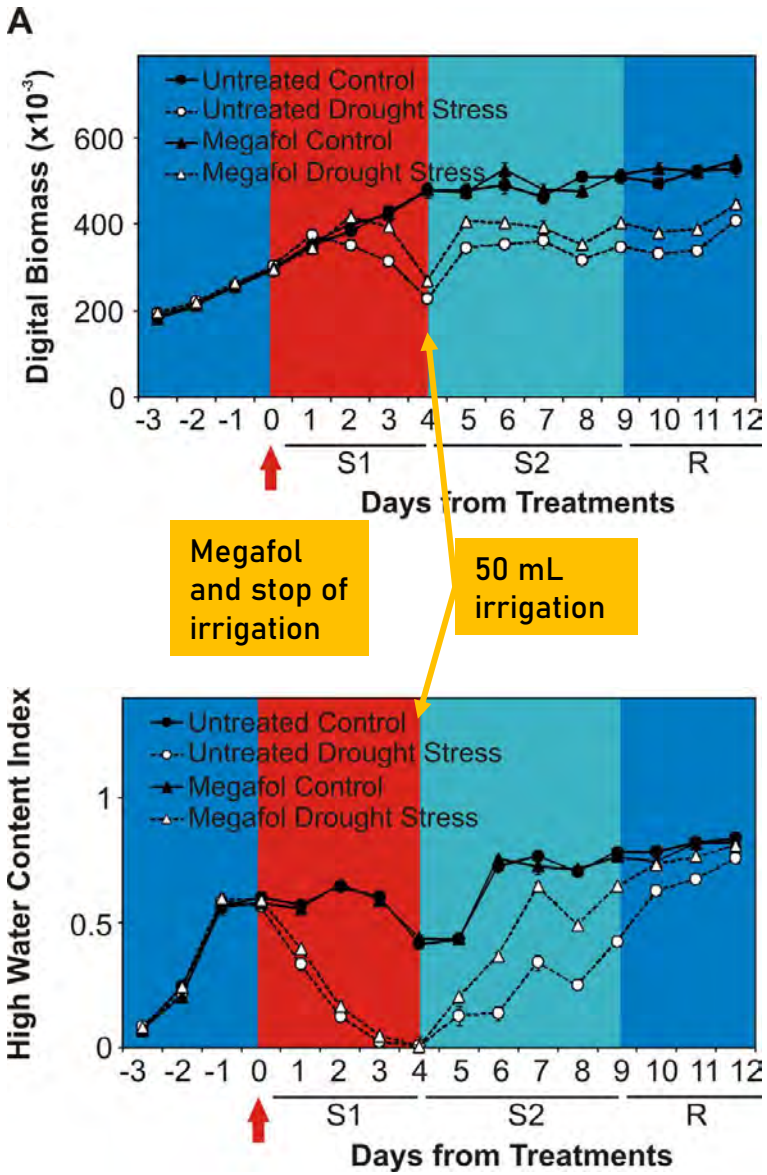
Physiological responses to Megafol® treatments in tomato plants under drought stress: A phenomic and molecular approach

Angelo Petrozza[a,1], Antonietta Santaniello[b,c,1], Stephan Summerer[a], Gianluca Di Tommaso[c], Donata Di Tommaso[c], Eleonora Paparelli[b], Alberto Piaggesi[c], Pierdomenico Perata[b], Francesco Cellini[a]

[a] ALSIA Centro Ricerche Metapontum Agrobios, s.s. Jonica 106, km 448,2, Metaponto, MT 75010, Italy
[b] PlantLab, Institute of Life Sciences, Scuola Superiore Sant'Anna, Piazza Martiri della Libertà 33, Pisa 56127, Italy
[c] Valagro S.p.A, via Cagliari 1, Atessa, CH 66041, Italy

ALSIA agricoltura 2.0





Efficent water use in desert-adapted wild tomato species

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DONALD DANFORTH
PLANT SCIENCE CENTER
DISCOVERY | COMMUNITY | IMPACT

Genetic Architecture and Molecular Networks Underlying Leaf Thickness in Desert-Adapted Tomato *Solanum pennellii*[1][OPEN]

Viktoriya Coneva,[a,3] Margaret H. Frank,[a] Maria A. de Luis Balaguer,[b] Mao Li,[a] Rosangela Sozzani,[b] and Daniel H. Chitwood[a,2,3]

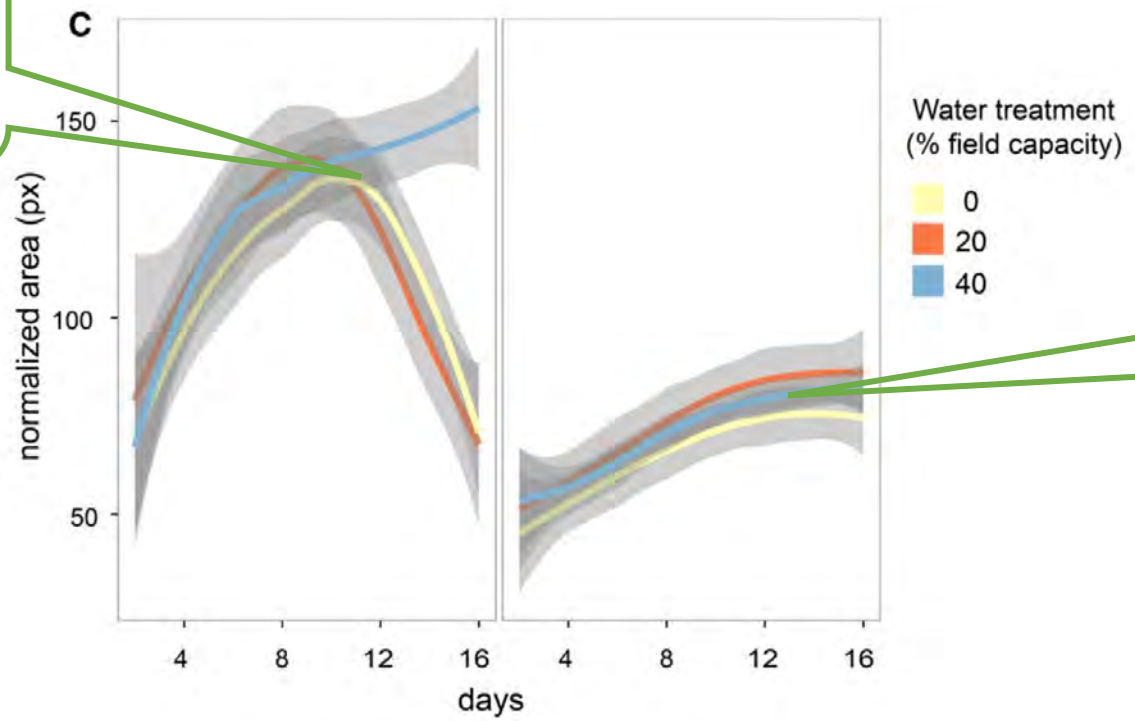
[a]Donald Danforth Plant Science Center, St. Louis, Missouri 63132
[b]Department of Plant and Microbial Biology, North Carolina State University, Raleigh, North Carolina 27695

ORCID IDs: 0000-0002-0640-5135 (V.C.); 0000-0002-5964-1764 (R.S.); 0000-0003-4875-1447 (D.H.C.).

Growth stop and wilting at low water availability

S. lycopersicum
Cultivated tomato

S. pennellii
Desert-tomato



Growth continues without wilting at low water availability

Cereals – response to water limitation

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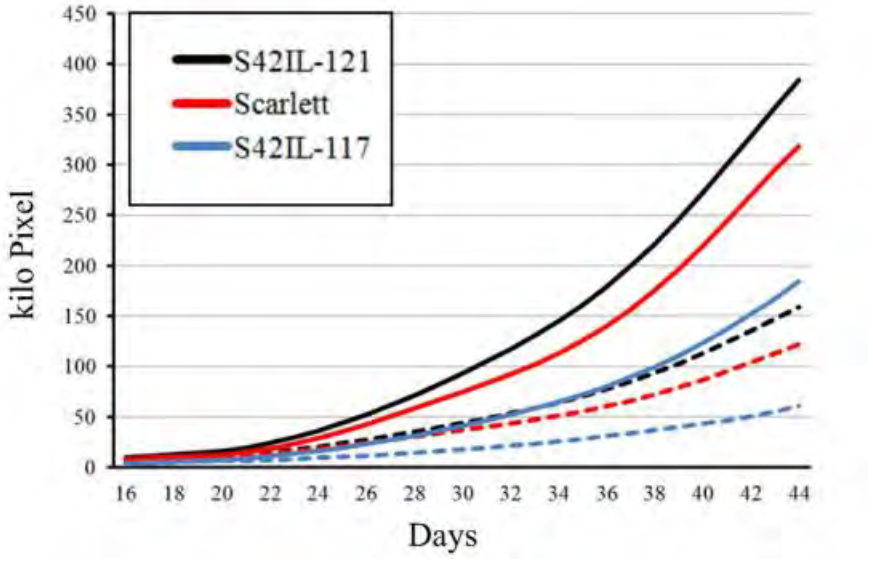
Measurement – parameters – information – knowledge
Images – plant area data – biomass calculation – QTL discovery

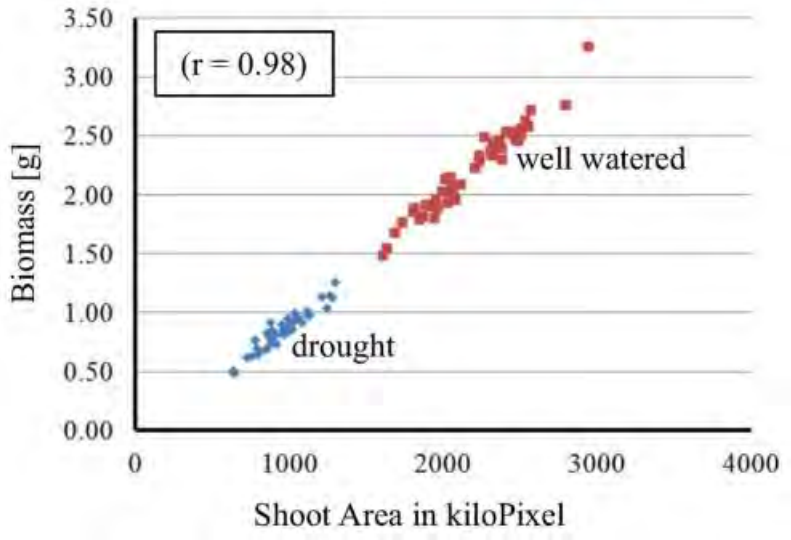
Australian Plant Phenomics Facility

High-Throughput Phenotyping to Detect Drought Tolerance QTL in Wild Barley Introgression Lines

Nora Honsdorf[1,2], Timothy John March[3], Bettina Berger[4], Mark Tester[5], Klaus Pillen[1]*

1 Chair of Plant Breeding, Institute of Agricultural and Nutritional Sciences, Martin-Luther University Halle-Wittenberg, Halle (Saale), Germany, **2** Interdisciplinary Center for Crop Plant Research (IZN), Halle (Saale), Germany, **3** School of Agriculture, Food and Wine, University of Adelaide, Waite Campus, Adelaide, Australia, **4** The Plant Accelerator, University of Adelaide, Waite Campus, Adelaide, Australia, **5** Center for Desert Agriculture, King Abdullah University of Science and Technology, Thuwal, Saudi Arabia





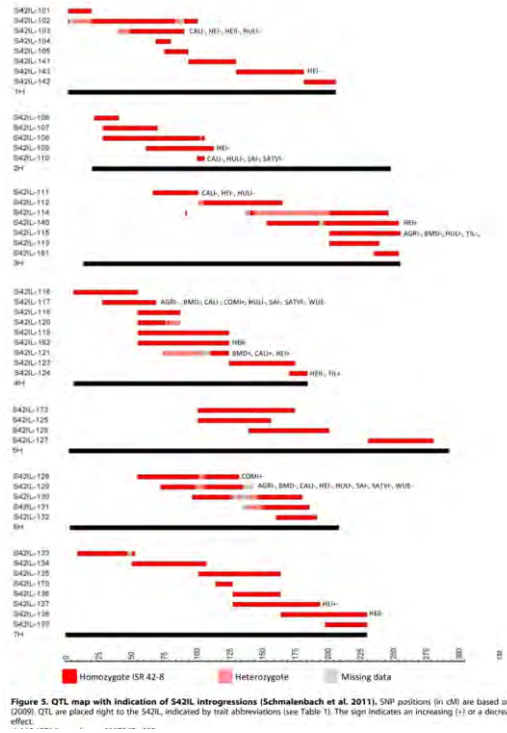
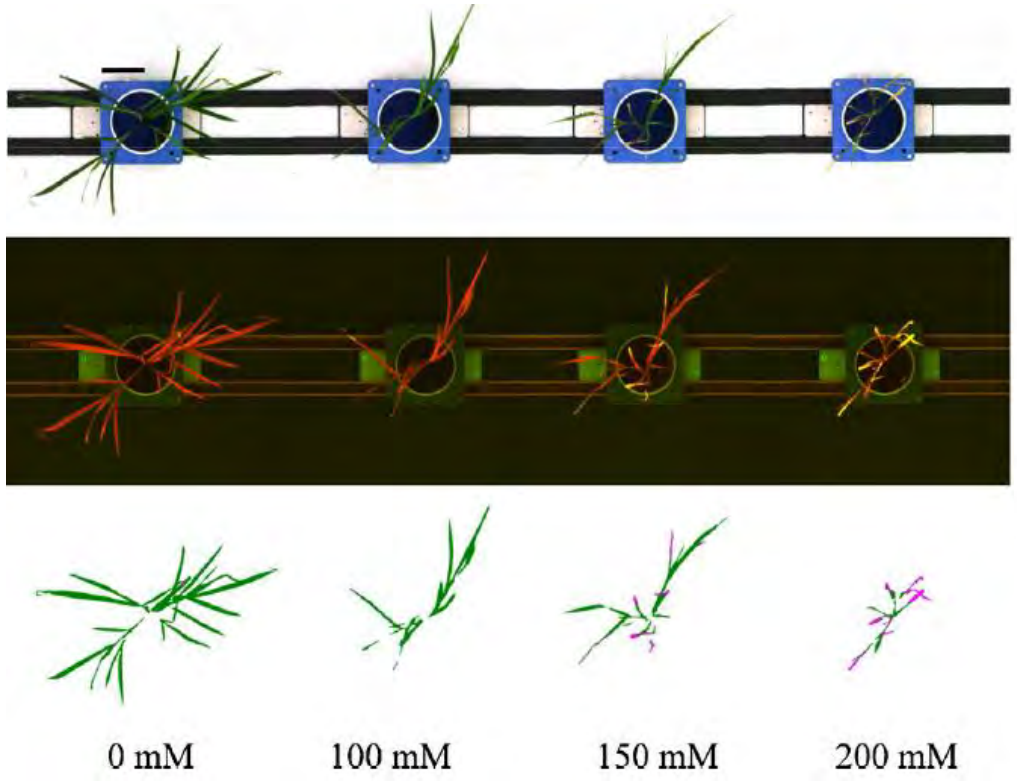


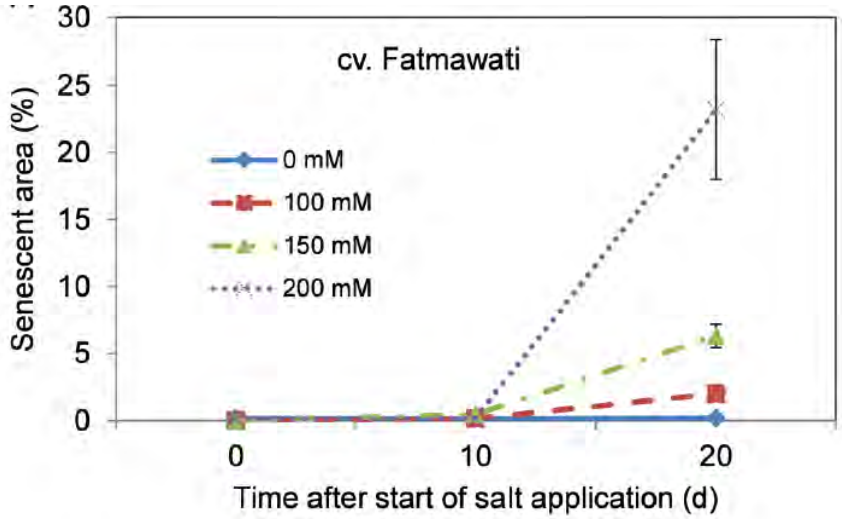
Figure 5. QTL map with indication of S42IL introgressions (Schmalenbach et al. 2011). SNP positions (in cM) are based on Close et al. (2009). QTL are placed right to the S42IL, indicated by trait abbreviations (see Table 1). The sign indicates an increasing (+) or a decreasing (–) *Hsp* effect.

Rice salinity responses

Hairmansis A, Berger B, Tester M, Roy SJ (2014) Image-based phenotyping for non-destructive screening of different salinity tolerance traits in rice. Rice 7: 16

Fluorescence signals -> Senescence



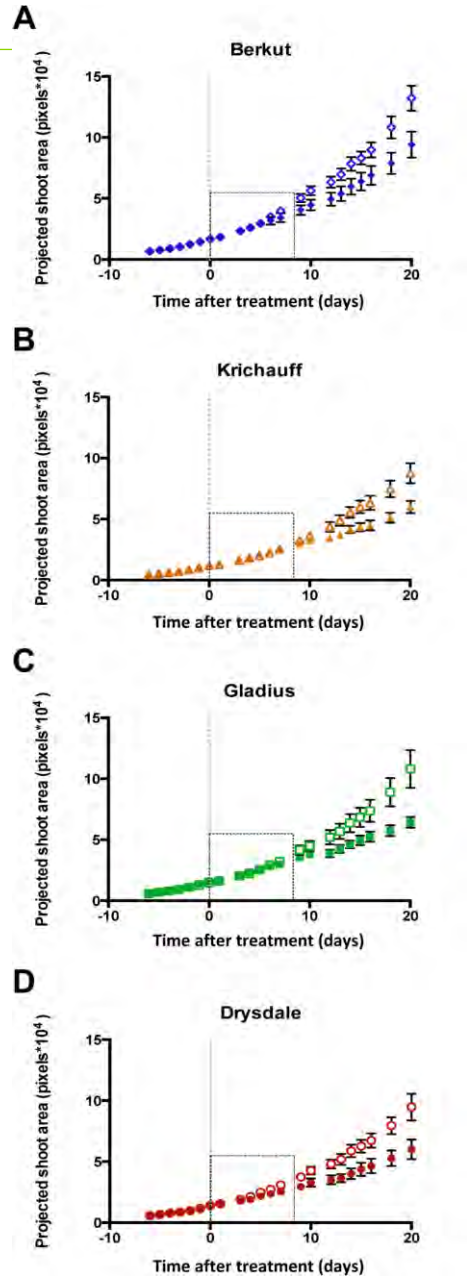


Wheat growth responses to salinity

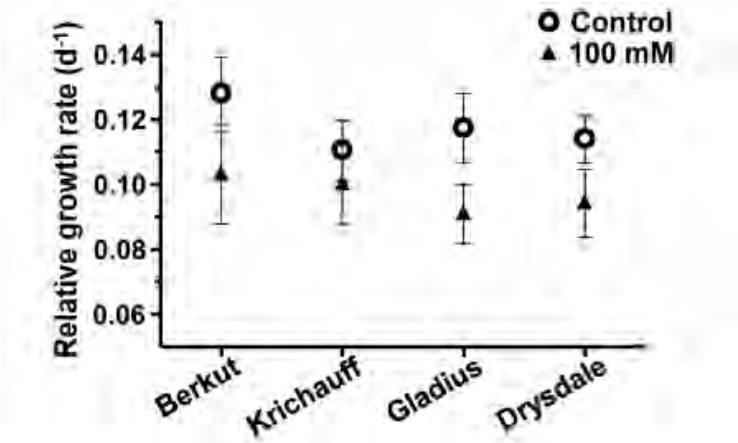
Salinity threatens agriculture in many areas of the world

Irrigation promotes salinity

Excess salt negatively affects plant physiology and finally reduces crop yield



Cultivar-specific growth rate reduction after salinity treatment



PLOS ONE

RESEARCH ARTICLE

Comparison of Leaf Sheath Transcriptome Profiles with Physiological Traits of Bread Wheat Cultivars under Salinity Stress

Fuminori Takahashi[1,2,4☯*], Joanne Tilbrook[3☯], Christine Trittermann[3], Bettina Berger[4], Stuart J. Roy[3], Motoaki Seki[5], Kazuo Shinozaki[1,2], Mark Tester[3,4¤*]

1 Biomass Research Platform Team, RIKEN Center for Sustainable Resource Science, Koyadai, Tsukuba, Ibaraki, Japan, **2** Gene Discovery Research Group, RIKEN Center for Sustainable Resource Science, Koyadai, Tsukuba, Ibaraki, Japan, **3** Australian Centre for Plant Functional Genomics, School of Agriculture, Food & Wine, University of Adelaide, Glen Osmond, Australia, **4** The Plant Accelerator, Australian Plant Phenomics Facility, School of Agriculture, Food & Wine, University of Adelaide, Glen Osmond, Australia, **5** Plant Genomic Network Research Team, RIKEN Center for Sustainable Resource Science, Suehiro-cho, Tsurumi-ku, Yokohama, Kanagawa, Japan

CrossMark click for updates

RIKEN

Australian Plant Phenomics Facility

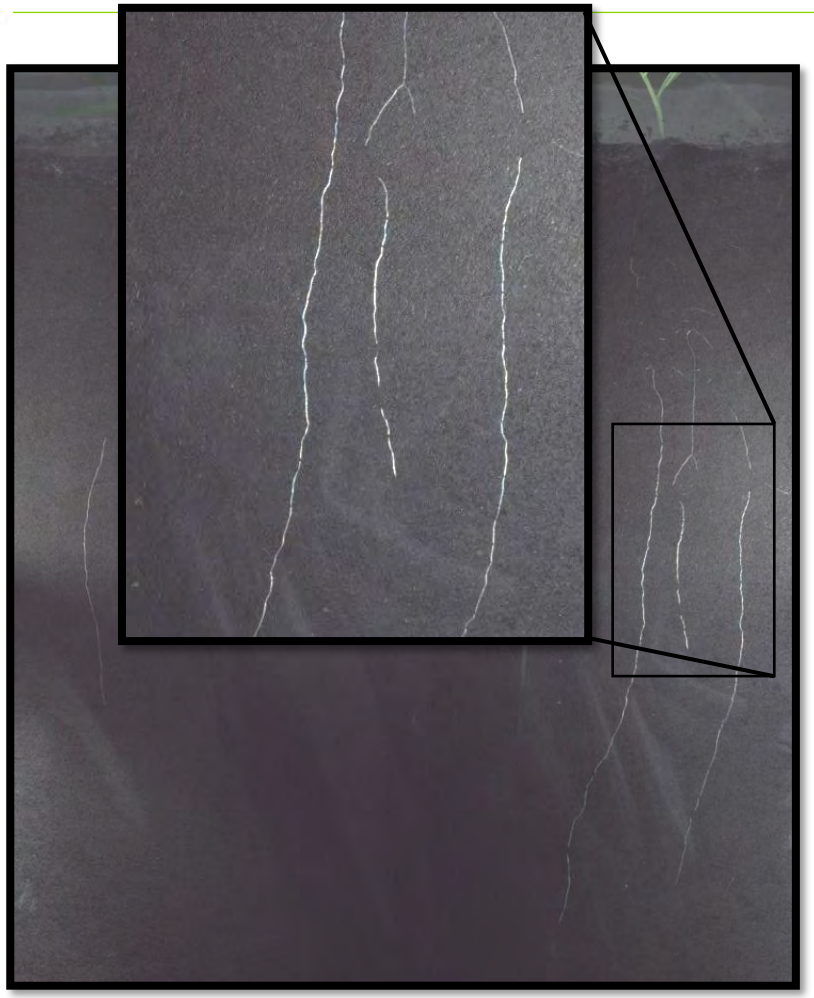
Root growth phenotpying in soil

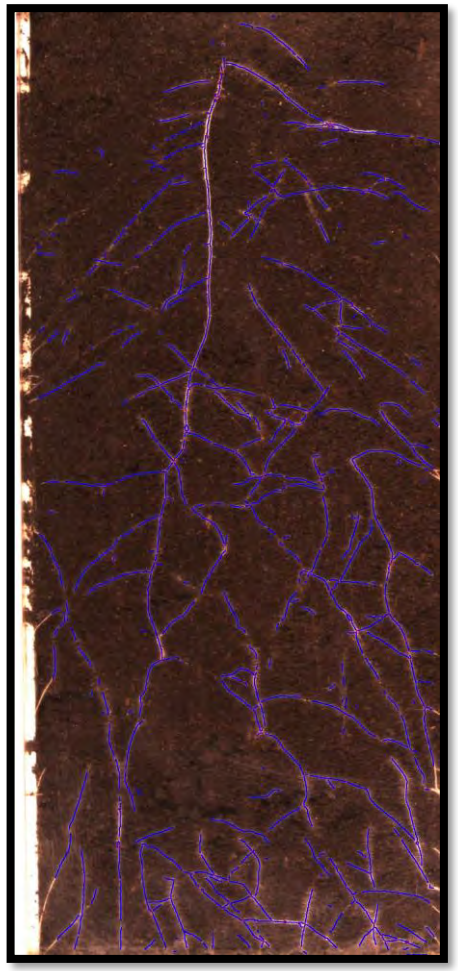
CSIRO PUBLISHING
Functional Plant Biology, 2012, **39**, 891–904
http://dx.doi.org/10.1071/FP12023

GROWSCREEN-Rhizo is a novel phenotyping robot enabling simultaneous measurements of root and shoot growth for plants grown in soil-filled rhizotrons

Kerstin A. Nagel[A,C], *Alexander Putz*[A], *Frank Gilmer*[A,B], *Kathrin Heinz*[A], *Andreas Fischbach*[A], *Johannes Pfeifer*[A], *Marc Faget*[A], *Stephan Blossfeld*[A], *Michaela Ernst*[A], *Chryssa Dimaki*[A], *Bernd Kastenholz*[A], *Ann-Katrin Kleinert*[A], *Anna Galinski*[A], *Hanno Scharr*[A], *Fabio Fiorani*[A] *and Ulrich Schurr*[A]

[A]Institute of Bio- and Geosciences, IBG-2: Plant Sciences, Forschungszentrum Jülich GmbH, 52425 Jülich, Germany.
[B]Present address: BASF SE, 67117 Limburgerhof, Germany.
[C]Corresponding author. Email: k.nagel@fz-juelich.de





Root imaging with GROWSCREEN Rhizo

- Soil-grown roots
- Automatic image recording
- Scalable system
- Applicable to many species
- Combination with shoot data

Image processing: root dimensions and architecture

Example:
Root tracking with LemnaTec software

Seed germination phenotyping

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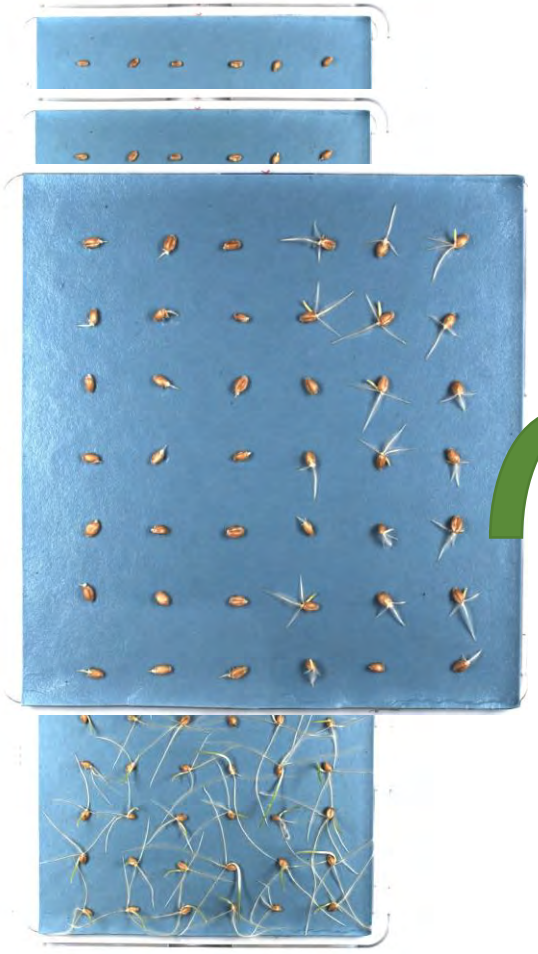
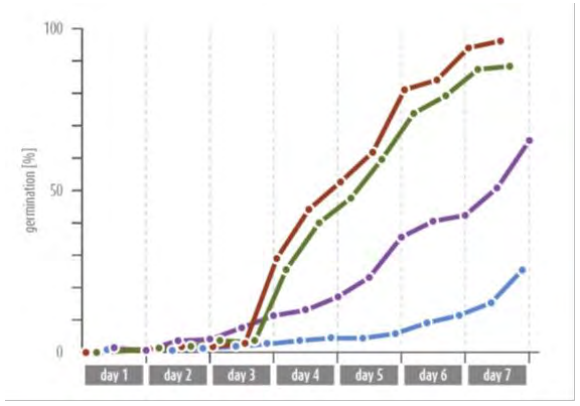
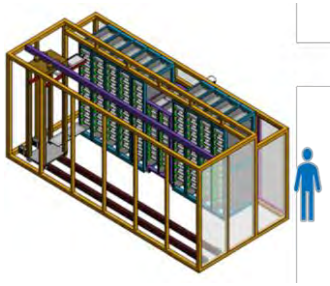
Germination test on paper



Machine learning

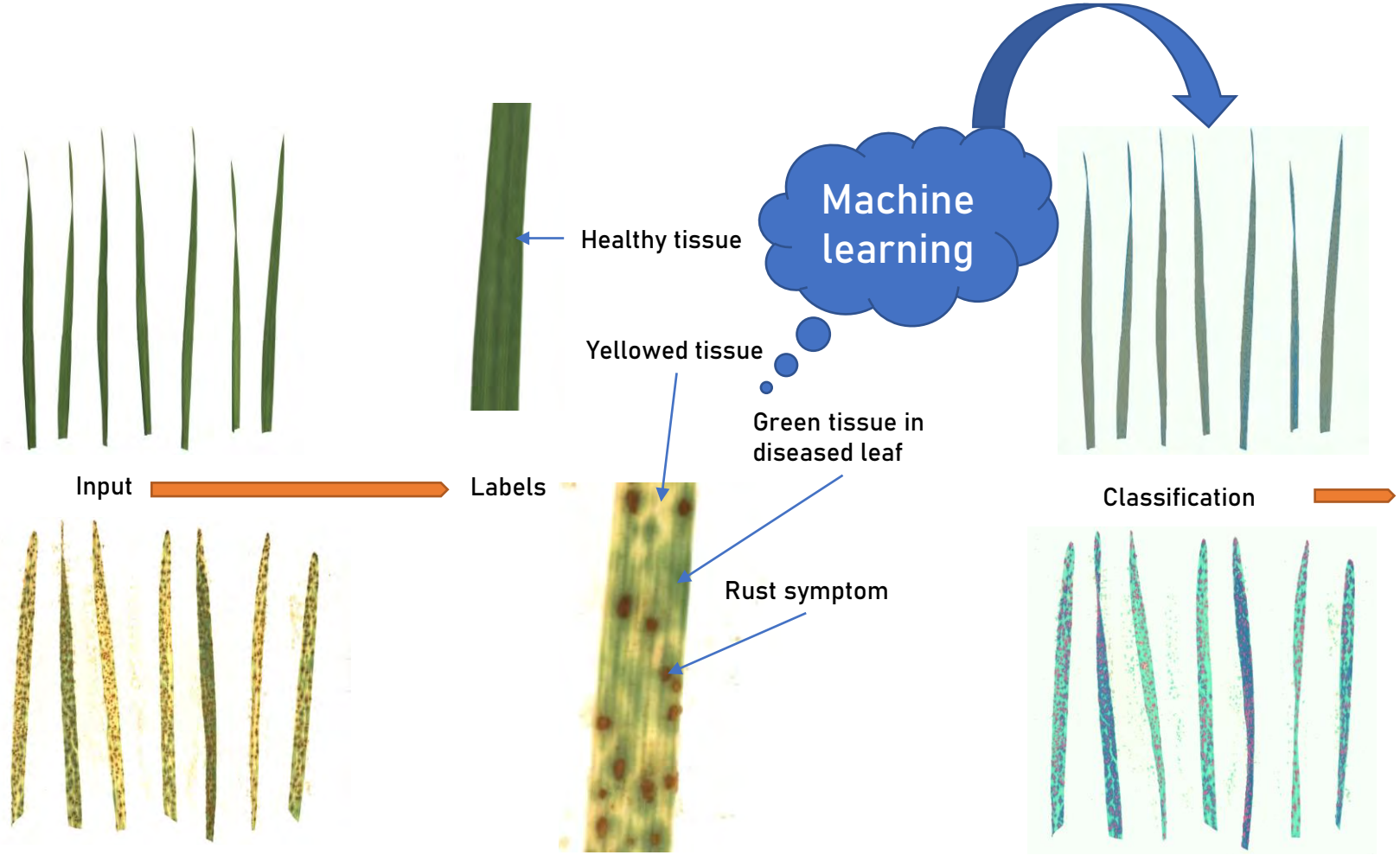


Vigour test



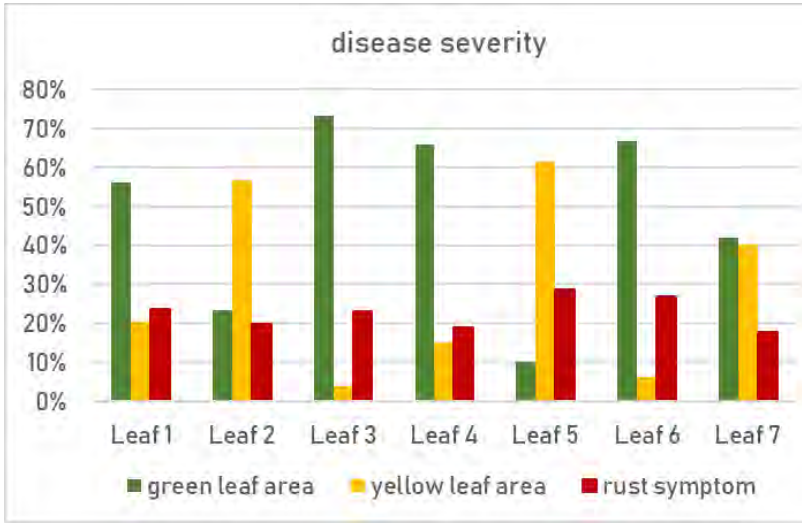
Disease symptom phenotyping with machine learning

Wheat rust infection – classification with machine learning



Lab Scanalyzer

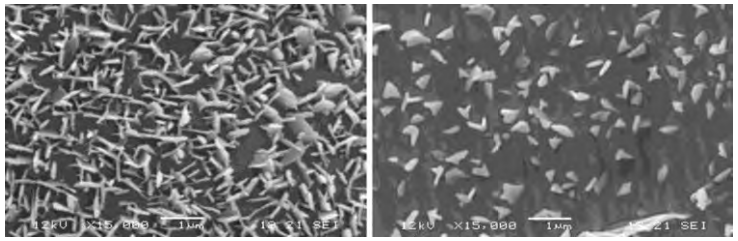
Conversion to biological information



Collaborative work with RWTH Aachen

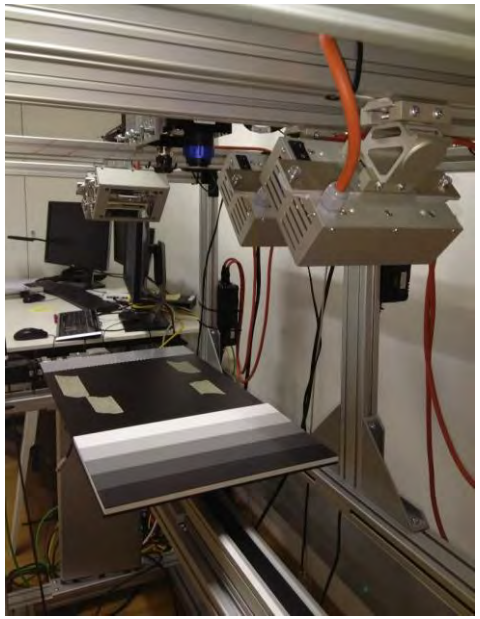
Spectral imaging for surface properties

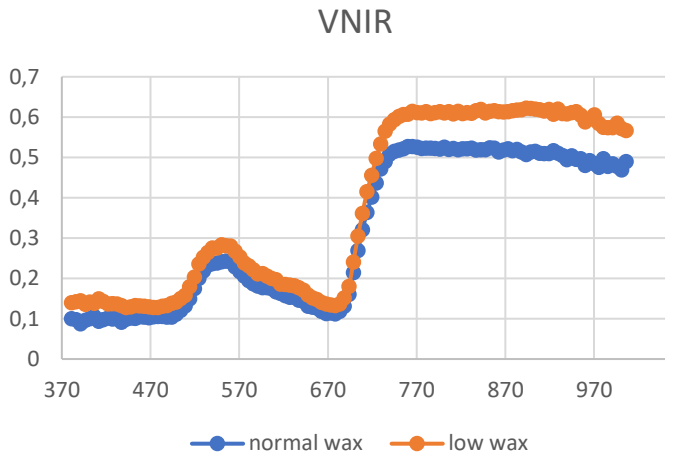
Normal wax Low wax

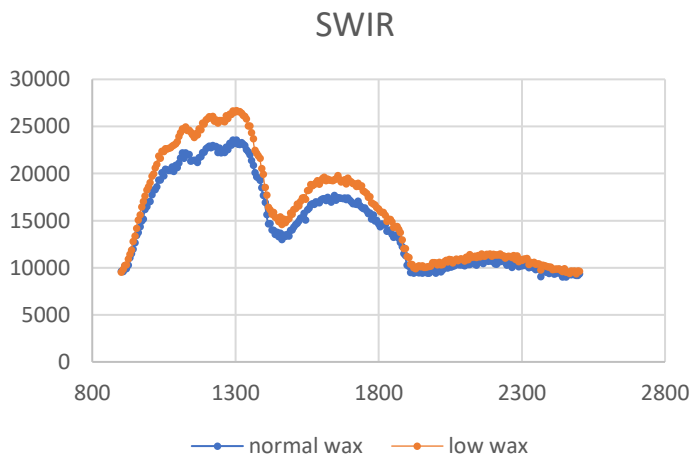


Low wax mutant
- Glossy bright green
- Less hydrophobic
- Spectral properties changed in VNIR and SWIR

Spectral reflectance recorded with hyperspectral cameras







Goal:
Link spectral properties with biochemical traits

Approach:
- Record datasets
- Corresponding biochemistry
- Machine learning
- Classification procedure