NEWSLETTER

2011/19

Zurich – Basel
Plant Science Center

University of Zurich[UZH]

UNI BASEL

ETH
Eidgenössische Technische Hochschule Zürich
Swiss Federal Institute of Technology Zurich

Editorial

The Zurich-Basel Plant Science Center can proudly look back on a very successful year. With 11 newly funded PhD or Post doc fellowships, it was once again able to increase its efforts to support interdisciplinary and transdisciplinary research in the area of plant sciences. Two new PSC-Syngenta fellowships have been awarded. A further four PhD fellowships were awarded at the interface of plant science research and policy thanks to generous funding by the Mercator Foundation, and six ProDoc PhD Fellowships were awarded by the SNSF as part of the new PSC PhD Program Plant Science and Policy. The PSC is now coordinating a unique PhD Program,which has extensive outreach and, as a result, the potential to improve implementation of new knowledge for the benefit of society.
The PSC has successfully launched two online-based writing platforms that have attracted great interest at the national level. The language center of the University of Zurich and ETH Zurich and the Pädagogische Hochschule Bern will include these platforms in their educational profiles.
These achievements, combined with the outstanding research competences of the PSC members, led to renewed recognition of the PSC as a centre of competence by the ETH Zurich and the Universities of Zurich and Basel. The PSC coordination office thanks all members.

PSC team

Awards

Lian Pin Koh won the SFIAR Award 2010 for his project "A spatially-explicit scenario analysis for reconciling agricultural expansion, forest protection, and carbon conservation in Indonesia" (Jaboury Ghazoul group).
Navreet Kaur Bhullar received the prestigious Garterslebener research award 2010 for her PhD thesis on gene mining for new powdery mildew resistance in wheat (Beat Keller group).
Yann Hautier (Andy Hector group) won the Harper Award for the best article by a scientist at the start of his career (Journal of Ecology 2010).

Upcoming events

2nd Workshop Plant Science and Policy: Stakeholder engagement. Botanical Garden, UZH: *2 March & 12 April 2011*

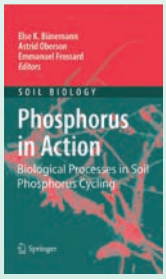
Fachtagung zur Grünen Gentechnik. Semper Aula, ETH Zurich: *2 September 2011*

Books

Biodiversität

B Baur 2010. UTB-Profile 3325. Haupt Verlag, Bern. ISBN 978-3-8252-3325-9. 127 p, CHF 15.90

Biodiversity science is a multidisciplinary subject, and this book addresses a broad range of key issues. It explains the history of life on earth, the reasons for the depletion and extinction of plants and animals, the reasons why humankind should be concerned about these losses, and the actions that can be taken to preserve some of what is left. This introductory textbook is aimed at undergraduates and postgraduates in plant science, environmental science, and zoology.



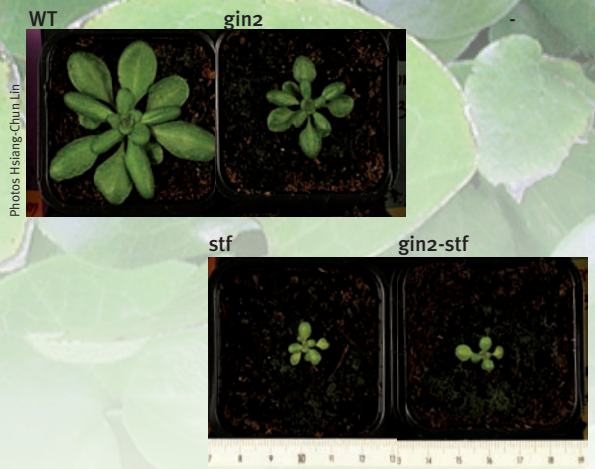
Phosphorus in Action –
Biological Processes in Soil Phosphorus Cycling

EK Bünemann, A Oberson, E Frossard (eds) 2011. Springer Soil Biology Series 26, Springer, NY, USA. 483 p, CHF 215.
ISBN: 978-3-642-15270-2

Phosphorus (P) is a finite resource which is essential for life. It is a limiting nutrient in many ecosystems, but it is also a pollutant that can affect biodiversity in terrestrial ecosystems and change the ecology of water bodies. This book collects and discusses the existing, up-to-date information on biological processes in soil P cycling, which to date have remained much less well understood than physical and chemical processes. The final chapter examines the interactions between global change and P cycling.

RESEARCH

This section presents results from a project that investigated the role of Hexokinase 1 (HXK1) in mediating glucose signals and was funded by the PSC-Syngenta research fellowship program. The research was part of Hsiang-Chun Lin's doctoral thesis, conducted under the supervision of Prof. Samuel Zeeman at the Institute of Agricultural Sciences, ETH Zurich and Prof. Enrico Martinoia of the Institute of Plant Biology, University of Zurich.



Photos Hsiang-Chun Lin

Phenotype of *Arabidopsis* plant growth on soil in high-light conditions. WT: Wild-Type (Ler); gin2; stf; gin2-stf.

The role of HXK1 in perceiving large changes in endogenous sugar levels in *Arabidopsis*

Sugars are the major products of photosynthetic carbon assimilation in higher plants. They are used as the primary carbon skeletons for biosynthesis and as energy metabolites. Sugars also acts as signaling molecules, and changes in sugar levels drive diurnal changes in the *Arabidopsis* transcriptome [1]. Starch-free mutants (stf), which cannot store excess photoassimilates as leaf starch, have greatly elevated sugars during the day but low sugars at night [1]. The expression of sugar-responsive genes is greatly accentuated in these plants. Different sugars elicit specific responses via distinct signaling pathways. Our understanding of these pathways is fragmentary. It is proposed that glucose modulates growth, photosynthesis, development, and stress responses in tissues ranging from developing embryos to senescing leaves. Previous studies revealed that the Arabidopsis mutant glucose insensitive2 (gin2) lacks Hexokinase 1 (HXK1) [2]. It has growth defects and is small compared to the wild type. Importantly, the metabolic function of HXK1 (to phosphorylate glucose to glucose 6-phosphate) can be uncoupled from its signaling activity. Mutant HXK1 proteins lacking catalytic activity can still support its signaling function [2]. However, most work has been done in non-physiological conditions (in the presence of high levels of exogenous glucose), and the extent of HXK1 signaling and its role in plants under physiological conditions are far from clear.

I want to define the contribution of HXK1 to the sugar-driven changes in gene expression and use this information to explain the gin2 mutant phenotype. I have used microarrays to compare wild type and gin2 during the day and at night. There are many changes in gene expression in gin2 during the day, but fewer at night, suggesting that HXK1 primarily transmits high-sugar signals. The regulated genes can be functionally categorized into micro-RNA pathways (repressed), stress responses (repressed) and starch metabolism (induced). I am also using the large changes in endogenous sugar levels that occur in stf mutants as a tool to test the robustness of the HXK1-dependent changes in gene expression. I combined the gin2 mutant with stf to create double mutant plants. These exhibit sugar excess during the day and sugar starvation at night, but they are also deficient in HXK1 signaling. Comparing these plants with the wild type and the single mutants, using microarrays, allows me to identify genes which consistently respond to sugars and to identify which of these are consistently deregulated by the loss of HXK1. Such genes show sugar-related changes in expression in the wild type and stf mutant but not in gin2 or the double mutant. In contrast to seedlings grown in the presence of exogenous glucose, our results suggest that the HXK1 is not a major regulator of photosynthetic gene expression but is primarily involved in the regulation of RNA metabolism, stress responses and hormone metabolism. My data provide new insights into the importance of HXK1-mediated glucose sensing. I plan to propose a plausible explanation as to how glucose signaling interfaces with the pathways regulating plant growth and development.

Hsiang-Chun Lin & Samuel Zeeman, Institute of Agricultural Sciences, ETH Zurich

Relevant Publications:

Bläsing OE, Gibon Y, Günther M, Morcuende R, Osuna D, Thimm O, Usadel B, Scheible W, Stitt M. Sugars and Circadian Regulation Make Major Contributions to the Global Regulation of Diurnal Gene Expression in *Arabidopsis*. The Plant Cell. 2005 Dec; 17: 3257–3281.

Moore B, Zhou L, Rolland F, Hall Q, Cheng W, Lui Y, Hwang I, Jones T, and Sheen J. Role of the *Arabidopsis* Glucose Sensor HXK1 in Nutrient, Light, and Hormonal Signaling. Science. 2003 Apr; 300: 332–336.

EDUCATION / SPSW

PhD Program in Plant Sciences, Spring 2011

- Online Collaboration, Publishing, Communicating and Creating a Web Presence – How to Make your Research Visible, Feb 7–8
- Scientific Writing Practice II, Feb 25 & Mar 18
- Workshop Plant Sciences and Policy: Stakeholder Engagement, Mar 2 & Apr 12
- Knowing what you are capable of and how to present it, Mar 7–8
- Introduction to Functional Genomics, Mar 14–16
- Introduction to Light Microscopy and Image Processing, Mar 21-23
- Project Management for Research, Apr 6, 7 & 20
- Scientific Presentation Practice, Apr 15 & May 6
- Responsible Conduct in Research for Plant Scientists, Mar 11 & Apr 15
- Next-Generation Sequencing for Model and Non-Model Species, May 25–26
- Introductory Course to R, June 06–08
- Summer School 2011: Terrestrial ecosystem dynamic in a changing world, Jun 21–24
- Conservation Field Course Scotland, Jul 3–11

Koexistenz und Forschungsfreiheit als Nagelprobe für die Grüne Gentechnologie (Proceedings of Grüne Gentechnologie 2009)
Dahinden M, Kohler S, Sautter C (eds) Idea-Verlag 2010,
ISBN: 978-3-88793-266-4
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SPSW

Since 2009, the PSC has been a member of the Swiss Plant Science Web (SPSW). In this section we present the latest activities and news related to the SPSW.

The success story of the PSC offers perfect proof of the immense value of a scientific network. The high quality and variety of the education offered and the research collaborations speak for themselves. We are convinced that with the Swiss Plant Science Web (SPSW), we can raise this success to the national level. The SPSW links the PSC to the other academic Swiss networks for plant sciences, namely BeNeFri (Universities of Bern, Neuchatel, Fribourg) and Arc Lémanique (Universities of Lausanne, Geneva). As an example, through the SPSW, it will be easier for PSC PhD students to participate in courses offered by other regional networks.
It is the aim of the SPSW to strengthen and to promote plant sciences in Switzerland. Operating at national level enables us to create new opportunities for encounter and collaboration, such as the recent SPSW Symposium in Meiringen, the SWISSPLANT'11. Furthermore, we provide access to the technology platforms of BeNeFri and Arc Lémanique, where chemical-analytical as well as bio-molecular analyses are performed. This service is available for both researchers and students, who can apply for mobility grants to cover accommodation and travel expenses. The next deadline is 28th February.
In 2011, the PSC is organizing a SPSW summer school on "Terrestrial ecosystem dynamics in a changing world". National and international scientific experts will share their knowledge and views with the PhD students who attend. Registration is still open.
Our particular concern is to promote Swiss plant science research, e.g. on our homepage, by giving media training, or by giving individual counseling on communications. Please don't hesitate to contact us.

Luca Wacker (Coordination/Technology Platforms),
Franziska Humair (Communications)
www.swissplantscienceweb.ch

www.spsw .ch

SCIENCE HIGHLIGHTS

Science 330:968-971 (2010)

Conserved molecular components for pollen tube reception and fungal invasion

Kessler SA, Shimosato-Asano H, Keinath NF, Wuest SE, Ingram G, Panstruga R, Grossniklaus U.

During sexual reproduction in flowering plants such as *Arabidopsis*, a tip-growing pollen tube (PT) is guided to the synergid cells of the female gametophyte, where it bursts and releases the two sperm. Here we show that PT reception and powdery mildew (PM) infection, which involves communication between a tip-growing hypha and a plant epidermal cell, share molecular components. NORTIA (NTA), a member of the MLO family originally discovered in the context of PM resistance, and FERONIA (FER), a receptor-like kinase, both control PT reception in synergids. Homozygous fer mutants also display PM resistance, revealing a new function for FER and suggesting that conserved components, such as FER and distinct MLO proteins, are involved in both PT reception and PM infection.

Genome Res 20:1229–1237 (2010)

Patching gaps in plant genomes results in gene movement and erosion of colinearity

Wicker T, Buchmann J, Keller B 2010.

Colinearity of genes in plant genomes generally decreases with increasing evolutionary distance while the actual number of genes remains more or less constant. To characterize the molecular mechanisms of this "gene movement," we identified non-colinear genes by three-way comparison of the genomes of Brachypodium, rice, and sorghum. We found that genomic fragments of up to 50 kb containing the non-colinear genes are duplicated to acceptor sites elsewhere in the genome. Apparent movement of genes is usually the result of subsequent deletions of genes in the donor region. Often, the duplicated fragments are precisely bordered by transposable elements (TEs) at the acceptor site. Highly diagnostic sequence motifs at these borders strongly suggest that these gene movements were the result of double-strand break (DSB) repair through synthesis-dependent strand annealing. In these cases, a copy of the foreign DNA fragment is used as filler DNA to repair the DSB linked with the transposition of TEs. Interestingly, most TEs we found associated with gene movement have a very low copy number in the genome, and for several we did not find autonomous copies. This suggests that some of these elements spontaneously arose from unspecific interaction with TE proteins that are encoded by autonomous elements. Additionally, we found evidence that gene movements can also be caused when DSBs are repaired after template slippage or unequal crossing-over events. The observed frequency of gene movements can explain the erosion of gene colinearity between plant genomes during evolution.

Nature 468:553–556 (2010)

Bottom-up effects of plant diversity on multitrophic interactions in a biodiversity experiment

Scherber C, Eisenhauer N, Weisser WW, Schmid B, Voigt W, Fischer M, Schulze ED, Roscher C, Weigelt A, Allan E, Bessler H, Bonkowski M, Buchmann N, Buscot F, Clement LW, Ebeling A, Engels C, Halle S, Kertscher I, Klein AM, Koller R, König S, Kowalski E, Kummer V, Kuu A, Lange M, Lauterbach D, Middelhoff C, Migunova VD, Milcu A, Müller R, Partsch S, Petermann JS, Renker C, Rottstock T, Sabais A, Scheu S, Schumacher J, Temperton VM, Tscharntke T

Biodiversity is declining, and this may negatively affect ecosystem processes. Studies show that biodiversity has positive effects on organisms and processes across trophic levels. So far, only few studies incorporate an explicit food-web perspective. We studied an unprecedented range of above- and below-ground organisms and multitrophic interactions. A multitrophic data set originating from a single long-term experiment allows mechanistic insights that would not be gained from the meta-analysis of different experiments. We show that plant diversity effects dampen with increasing trophic level and degree of omnivory. This was true both for abundance and species richness of organisms. We present comprehensive above-ground/below-ground biodiversity food webs. Both above ground and below ground, herbivores responded more strongly to changes in plant diversity than did carnivores or omnivores. Density and richness of carnivorous taxa was independent of vegetation structure. Below-ground responses to plant diversity were consistently weaker than above-ground responses. Responses to increasing plant diversity were generally positive but were negative for biological invasion, pathogen infestation and hyperparasitism. Our results suggest that plant diversity has strong bottom-up effects on multitrophic interaction networks, with particularly strong effects on lower trophic levels. Effects on higher trophic levels are indirectly mediated through bottom-up trophic cascades.

PSC MEMBER

Here we present group leaders. Through their creative research and involvement in teaching, group leaders make a substantial contribution to the success of the Zurich–Basel Plant Science Center.

Prof. Achim Walter: new PSC Member

Photo Achim Walter

Crop science is expected to provide innovative solutions to unprecedented, global challenges: More than a billion people suffer from hunger, while at the same time global climate change, land use conflicts, a decreasing availability of mineral nutrients and several other factors make it increasingly difficult for food production to keep pace with the ever-growing demands of the world population.

In the crop science group at the Institute of Agricultural Sciences, ETH Zurich, we seek to provide innovative pathways to identify and generate more versatile and efficiency-oriented crop production systems. Novel time-lapse imaging procedures acting at different spatial and temporal scales are core elements of the toolbox of our interdisciplinary team. In climate chambers, greenhouses and field sites, we apply visual, near-infrared and thermal imaging to quantify shoot and root architecture, dynamic and short-term growth processes as well as photosynthesis, gas exchange and compound composition of major and alternative crops alike. These 'phenotyping' analyses, in concert with a range of approaches from plant ecophysiology, breeding and molecular analysis, will help to elucidate plant genotypes and crop production systems that are optimized to regionally differing ecological niches. Moreover, they will facilitate an improved understanding of basic rules governing plant-environment-management interactions. This, in turn, is a necessary prerequisite to ameliorate the knowledge transfer between lab and field and between plant biology and agricultural sciences.

My research interests originate from studying exchange processes between plants and the environment and from studying rhythmic growth processes in leaves and roots. Research conducted in my group has shown characteristic differences in the growth dynamics of a number of plant species – especially between broad-leaved and grass species – and it has shown how signatures of growth patterns can be utilized to deduct the acclimation of a plant to its environment rapidly and non-destructively. Precise monitoring of growth and exchange processes needs to complement the description of molecular and hormonal control of plant growth and metabolism to advance knowledge on plant and crop science in the short term and to improve the applicability of this knowledge in the medium and long term.

Curriculum vitae

Achim Walter studied Physics, Biology and Environmental Sciences and received his PhD in 2001 in Biology from the University of Heidelberg. From 2001 to 2003, he was an Alexander von Humboldt Postdoctoral Fellow at Biosphere 2 Center, Arizona. From 2003 to 2010, he was a group leader and, since 2006, deputy director at the Phytosphere Institute of the Research Center Jülich, Germany, where he is still an adjunct scientist. He received his habilitation in Plant Biology from the University of Düsseldorf in 2009 and became professor of Crop Science at the Institute of Agricultural Sciences at ETH Zurich in September 2010.

Prof. Dr. Achim Walter
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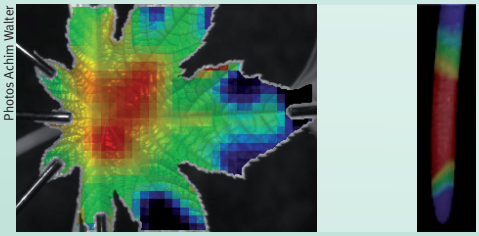
Photos Achim Walter



Above: Color-coded distribution of growth rates of a typical dicotyledonous leaf *(Ricinus communis)* (left) and of a typical root *(Zea mays)* (right) calculated from time-lapse image sequences (red: high growth rate, black: low).

Below: Crop plant development and phenotype will be analyzed in varying environments and in controlled conditions.

Photo Niclas Freitag

FOCUS

PhD Program Plant Sciences and Policy

Successful First Workshop Evidence-Based Policy Making

A very dedicated group of PhD students was introduced to the theory of evidence-based policy making. In interviews with policy makers, scientists and lobby groups they also gained insights into the practical implementation. Case studies focused on the topics of ecosystem services and landscape planning, invasive species, and assessments of external costs of agriculture. On the second day of the workshop, the students presented their experiences and conclusions and engaged in lively discussions. During the workshop, they were guided by and could interact with experts from governmental and non-governmental organisations, including Andrew Seidl, IUCN Headquarters, Switzerland, Andreas Hauser, FOEN, Switzerland, Holger Gerdes, Ecologic Institute, Germany, and Christian Pohl, td-net, transdisciplinary research, ETH Zurich.

Second workshop: Stakeholder Engagement
The next workshop will take place at the Botanical Garden, University of Zurich, March 2 and April 12, 2011. Details and registration: http://www.plantscience.ethz.ch/education/science_policy/courses

Launch of Four PSC-Mercator PhD Fellowships 'Bridging Plant Sciences and Policy'

Four transdisciplinary projects funded by the Mercator Foundation Switzerland form part of the PSC's efforts to establish a plant science and policy platform. The projects are supervised by a research group from the PSC as well as by stakeholders involved in the policy-making process, i.e. the Federal Office for the Environment, the UNEP, and the CITES Secretariat. Policy aspects are already embedded in the research outlines, and students will conduct a six-month internship in the partner policy organisation, thus ensuring close collaboration. As part of the individual theses, the students will write a green paper to be used as a base for political implementation. Information on individual projects that will start between January and March 2011 can be found at: http://www.plantscience.ethz.ch/education/science_policy/Phd_students

New ProDoc Research Modules 'Plant Sciences and Policy'

Updated information on the six PhD projects that are currently being funded and which will start between January and March 2011 can be found at: http://www.plantscience.ethz.ch/education/science_policy/Phd_students

An additional call for proposals for up to four more PhD fellowships is open, and submissions should be made by 1 March 2011. For **more information,** please contact Dr. Andrea Pfisterer (info-plantscience@ethz.ch)

Students on both fellowship programs participate in the Plant Science and Policy PhD program.

Impressum

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