Universität Zürich[UZH] | ETH zürich | Universität Basel

Zurich-Basel Plant Science Center

PSC & Syngenta
Symposium 2023

Arabidopsis thaliana

PROGRAM

KEYNOTES

Chair: Bruno Studer, ETH Zurich

10:00-10:10
Welcome and introductory words
Bruno Studer, ETH Zurich

10:10-10:30
Sustainable Innovation in Syngenta
Steve Maund, Head CP R&D Sustainability, Syngenta

10:30-10:50
Keynote PSC on soil resources
Gina Garland, ETH Zurich

10:50-11:10
Keynote PSC on plant-soil interactions
Joëlle Schläpfer, University of Zurich

11:10-11:30
Discussion: Questions & Answers

FELLOW PRESENTATIONS

Chair: Gina Garland, ETH Zurich

11:30-11:45
Unearthing the mechanisms of carbon retention in soil and linking them to farmer practices
Dr. Luiz Alberto Domeignoz Horta, Post-doc at University of Zurich

11:45-12:00
Plant ecological airborne indicators for response, plant Eco-AIR
Dr. Sergio Ramos, Postdoc at University of Zurich

12:00-13:45
Lunch Break

Chair: Joëlle Schläpfer, University of Zurich

13:45-14:00
Mycorrhiza and intercropping systems to stabilize and increase yields of small holder farmers in the drylands
Santiago Perez, University of Basel, PhD-Fellow

14:00-14:15
Action of essential bacterial effectors on conserved plant receptor kinases: towards strategies for durable and broad-spectrum disease resistance
Laura Herold, University of Zurich, PhD-Fellow

14:15-14:30
Effects of microbial endosymbionts on the transmission of plant pathogens by aphid vectors
Patricia Sanches, ETH Zurich, PhD-Fellow

14:30-14:45
Deciphering plant exudate and root microbiota dynamics during pathogen attack
Charlotte Joller, University of Basel, PhD-Fellow

14:45-15:00
ChromID: exploring the plant epiproteome
Miguel Wente, University of Zurich, PhD-Fellow

15:00-15:30
Coffee Break

KEYNOTES

Chair: Willy Rueegg

15:30-16:00
Syngenta Foundation - a bright future for smallholder farming
Yuan Zhou, Syngenta Foundation

16:00-16:30
Innovation!
Claudio Screpanti, Syngenta

16:30-16:50
Discussion: questions & answers

16:50-17:00
Summary and final remarks
Willy Rueegg, Syngenta, Head CPRB

WEDNESDAY, March 22nd, 2023

PLANTSCIENCES.CH

REGISTRATION LINK

Deciphering plant exudate and root microbiota dynamics during pathogen attack
Klaus Schläppi (University of Basel) & Joëlle Schläpfer (University of Zurich)
Charlotte Joller, PhD student
Plants under pathogen attack adjust the composition of their microbiome and thereby, enrich for beneficial strains with protective functions. However, it is currently unclear how plants modulate their microbial communities. Metabolites exported from roots are nutrients and signaling compounds to the microbial community. We hypothesize that altering the exudation of specific compounds presents the mechanistic link between microbe recognition and changes in the composition of plant-associated microbial communities. The objective of this project is to understand how plants alter exudation under pathogen attack, resulting in a modulated root microbiome. To accomplish this, we employ a reductionistic approach by growing *Arabidopsis thaliana* in sterile microcosm systems, by simulating pathogen attack by the application of elicitors, and studying the effects on a synthetic bacterial community. We first establish an experimental setup permitting paralleled metabolic and microbial analyses, then we identify candidate metabolites changing in response to immune stimulation, validate their effects on microbes and finally, we reassess the relevance of these key exudate compounds under natural conditions. With this project, we will make a step towards understanding the mechanistic link between a plant host and its microbiome during pathogen attack. The identification of such key exudate metabolites will permit future breeding towards cultivars with 'disease-protective microbiomes' as sustainable solution to control pathogen burden.

ChromID: Exploring the plant epiproteome
Sylvain Bischof (University of Zurich), Kirsten Bomblies (ETH Zurich)
Miguel Wente, PhD student
As the global climate continues to change, environmental stresses such as extreme temperature and drought are becoming increasingly common and threaten to diminish the world's agricultural output. To cope with these challenges, the hardiness and stress resistance of our crops must be increased. In addition to genetic adaptation, plants have evolved epigenetic mechanisms to respond to biotic and abiotic stresses. Chromatin modifications and DNA methylation are important epigenetic components of gene regulation which affect how rapidly and efficiently plants respond to environmental stresses. To date, most of the proteins involved in depositing, removing, or interacting with these chromatin modifications and DNA methylation are still unknown. In the Bischof lab, we have established a new method in plants that allows for the identification of proteins that „read", „write" or „erase" DNA methylation and histone post-translational modifications. This project aims at identifying and characterizing the factors associated with both activating and silencing epigenetic marks. With this knowledge, we can gain insight into the epiproteome of plants and identify targets for future plant-breeding programs aimed at increasing stress tolerance.

Effects of microbial endosymbionts on the transmission of plant pathogens by aphid vectors
Mark Mescher, Clara Sanchez-Rodriguez, Consuelo De Moraes (ETH Zurich), Anke Buchholz (Syngenta)
Patricia Sanches, PhD student
Interactions between aphids and endosymbiotic bacteria have been studied extensively as models of evolutionary mutualism. Recent research indicates that symbionts can also have important effects on interactions between aphids and other organisms. For example, it has been suggested that some endosymbiotic bacteria enhance the ability of their host aphids to colonize novel host plants. Mutualistic symbionts may also have effects on interactions involving other aphid-associated microbes, including aphid-vectored plant pathogens. However, little is currently known about the potential effects of aphid endosymbionts on disease transmission. To address this gap in our current knowledge, this PhD project explores how endosymbionts influence aphid-plant-virus interactions. Specifically, it explores how aphid association with different microbial endosymbionts influences: (i) aphid preferences for and performance on infected plants; (ii) defence responses of virus-infected and healthy plants; (iii) aphid susceptibility to natural enemies; and (iv) the acquisition, retention, and transmission of plant viruses by aphid vectors. The knowledge produced by this PhD project will provide new insights into disease ecology and into the ecology and evolution of aphid interactions with endosymbionts. Furthermore, this project will lay the foundation for future work on the implications of endosymbionts for the spread of viral plant diseases, with potential relevance for efforts to control the spread of economically important diseases in agricultural systems.

Action of essential bacterial effectors on conserved plant receptor kinases: towards strategies for durable and broad-spectrum disease resistance
Cyril Zipfel (University of Zurich), Giovanni Broggini (ETH Zurich), Euiwhan Chung (Syngenta)
Laura Herold, PhD student
Crop losses are caused by pathogens and pests, which threaten food security and also impose significant monetary and/or environmental costs to control the ensuing diseases using chemicals. A more sustainable approach is to use genetics to increase disease resistance against important pathogens in crops. This however requires a more detailed understanding of the molecular mechanisms controlling the interaction between pathogens and their host plants. This proposal is based on the characterization of conserved, essential proteins that are injected within plant cells by pathogenic bacteria. These proteins, called effectors, are key determinant of virulence and thus of disease establishment and/or progression. We will identify the plant proteins that are targeted by these effectors, characterize the impact that the effectors have on the targeted proteins, as well as reveal the role of these plant proteins in plant immunity (or other processes). Using this information, we will then use precise modern genome-editing techniques to debilitate the targeting of these proteins by bacterial effectors so that plants are more resistant to phytopathogenic bacteria. This research – guided by phylogenetic insights – will rely on a detailed comparative study between the model plant *Arabidopsis thaliana* and the fruit crop apple, which will ultimately allow the direct translation of the results in apple. As such, this project will provide both significant scientific insights and potential practical applications for crop protection. Furthermore, collected data will contribute to evidence-based discussions with policy makers and the public on the use of genome-edited crops to tackle important challenges facing modern agriculture.

Mycorrhiza and intercropping systems to stabilize and increase yields of small holder farmers in the drylands
Ansgar Kahmen and Mathimaran Natarajan (University of Basel), Astrid Oberson (ETH Zurich)
Santiago Perez Bernal, PhD student
Agroecology takes advantage of natural ecosystems services and uses local knowledge to plant a diversity of crops that boost the sustainability of the farming system as a whole. In the light of climate change, densely populated areas of the drylands and semiarid regions face unpredictable patterns of rain and scarcity of non-renewable resources such as fertilizers and soils. Intercropping practices are rising as feasible means to address some of these problems. These systems take advantage of ecological principles such as resource-use efficiency and biodiversity to increase food production and the resilience of crops. Biofertilizers centered around arbuscular mycorrhizal fungi (AMF) and plant growth promoting rhizobacteria (PGPR) are additional options to mineral fertilizers well-known for their far-reaching beneficial effects to plants such as increased drought resistance, improvement grain yields and nutritional quality. We tested different cropping systems, planting arrangements and combinations of intercropped plant species across different seasons and locations to assess the performance of biofertilizers mediating intercropping advantages of staple crops from southern India. The aim of this project was to test biofertilizers as a new and cost-effective tool for dryland agriculture, that will help to stabilize and increase the yields of small holder farmers that are particularly exposed to the consequences of a changing climate.

Unearthing the mechanisms of carbon retention in soil and linking them to farmer practices
Anna-Liisa Laine (University of Zurich) and Ansgar Kahmen (University of Basel)
Dr. Luiz Alberto Domeignoz Horta, Postdoc
Soils are the largest and most dynamic terrestrial carbon (C) pool, storing 2000 Pg of C more than the atmosphere and biosphere combined. However, agriculture has caused the loss of approximately 60 Pg soil C since the beginning of industrial period. Despite this, improving agricultural practices can also be used to counteract rising CO_2 levels. As agroecosystems represent over 40% of earth surface today, they must be part of the solutions put in action to mitigate climate change. The utility of "carbon farming" – or the use of management practices to maximize soil carbon storage – is currently limited by a poor understanding of how the plants which input carbon to soil and the microbes which determine its fate there interact with one-another. Here we will elucidate the potential of different plant functional types to foster soil organic matter formation and persistence in soils though their interactions with soil microbial communities. By characterizing the molecular signature of biomass from diverse plant functional types in lab and field experiments characterized by distinct plant communities, we will evaluate the hypothesis that more molecularly diverse soil organic matter (SOM) persists longer in soils. The distinct plant functional types are implemented within a long-term intercropping farming experiment which will allow us to bring our results into an agricultural context. This project will link various disciplines including plant functional ecology, microbiology, stable isotopes and soil biogeochemistry to shed light into how farmers can implement more sustainable practices and help sequester carbon back into soils.

Plant ecological airborne indicators for response, plant Eco-AIR
Meredith C. Schuman (University of Zurich), Stefano Mintchev (ETH Zurich), Anke Buchholz (Syngenta)
Dr. Sergio Ramos, Postdoc
Global change, characterized by climate change and biodiversity loss, is aggravated by unsustainable monocropping practices. Mixed cropping practices may not achieve the shorter-term yields per acre of intensive monocropping but can ensure more stable yields in the long term, and are amenable to sustainable intensification (SI). Mixed cropping and SI are more work- and knowledge-intensive for farmers due to more heterogeneous fields with different plants requiring different management, and thus successful targeted management is critical, especially when yearly yield margins may be smaller. Precision agricultural tools, especially scalable approaches using drones for image capture, can support targeted management of heterogeneous fields. This is helpful in monocrops, where heterogeneity comes from environmental patchiness e.g., in water retention or pest load, indicating a need for diversified management; and it is even more important for mixed cropping. A current limitation is that imaging, even using hyperspectral sensors, is best at identifying plant stress responses in a later stage when there is bulk damage to plant parts. Early-stage plant stress responses employ bioactive phytochemicals produced as a small percentage of biomass, which are challenging to assess in the "bulk measurement" from a drone-based image. Thus, while drone-based imaging supports adaptive management, it provides limited support for early interventions to prevent yield loss. However, some stress-responsive phytochemicals comprise a tailored "early warning system" evolved by plants: volatiles released to the environment for defence and communication. A promising SI practice, push-pull technology (PPT), even uses species-typical volatiles from intercrops and trap crops to defend a focal crop against pests, and thus plant volatiles should be very good indicators of SI effectiveness in this system. We will (1) develop a drone-based system to sample volatiles near individual plants, and of patches on the scale of PPT mixed cropping units, i.e., an intercropped patch or crop-trap crop interface; (2) identify volatile indicators from literature and field measurements, and (3) demonstrate drone-based monitoring of volatile indicators for yield loss prevention in both monocrop and PPT mixed-crop maize fields.

Background picture: *Brachypodium distachyon*