WORKSHOP

Crops and the changing climate: physiology and genetics to improve plants adaptation to reduced water availability

The workshop would focus on the plant response to water stress in terms of the activation of molecular pathways and physiological mechanisms involving shoot and root characteristics. Results from grapevine, cereals and model plants will be presented.

WORKSHOP DATE AND PLACE:
The workshop will be held on 12 June 2025 from 9:00 to 12:30 (Italian time) in the conference room of the PRC building (3rd floor).

WORKSHOP LANGUAGE:
English

INDICATIVE PROGRAM

Time	Speaker	Title of the presentation	
9:00 – 9:30	**Michele Faralli** (C3A); **Lorenza Dalla Costa** (FEM)	Introduction to the aim of the workshop with some hints to the STOMALTER project	In presence
09:30 – 10:00	**Olivier Zekri** (Mercier)	Viticulture Under Pressure: Why We Must Adapt Grapevine Traits to Meet Emerging Challenges	online
10:00 – 10:30	**Fabio Fiorani** (Forschungszentrum Jülich)	Integration of root-specific traits into resilient crop ideotypes	In presence
10:30 – 11:00	**Massimo Galbiati** (Consiglio Nazionale delle Ricerche -CNR)	Exploiting the transcriptional control of stomatal activity for plant water productivity and drought resistance	In presence
11:00 – 11:30	**Coffee break**		
11:30 – 12:00	**Tracy Lawson** (University of Illinois)	Manipulating Stomatal Response to Improve Water Use efficiency	online
12:00 – 12:30	**Simon Unterholzner** (Libera Università di Bolzano)	Unveiling the link between energy availability and drought stress response in the Arabidopsis root	In presence

SPEAKERS

Olivier Zekri

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Title of the presentation:
Viticulture Under Pressure: Why We Must Adapt Grapevine Traits to Meet Emerging Challenges

Abstract:

Viticulture is currently facing unprecedented challenges, driven primarily by climate change and the phasing out of key chemical inputs. Growers must contend with increasingly hot and extreme weather patterns—alternating between heavy rainfall and prolonged droughts—as well as milder winters and the aggressive resurgence of plant pathogens such as downy mildew, grapevine wood diseases, viruses, and insect pests. As grapevine is a perennial crop, the tools available to winegrowers for adapting to these pressures are limited once a vineyard is established. Traditional levers such as soil and canopy management, fertilization, and biocontrol remain essential. However, genetic innovation is emerging as a complementary and powerful strategy to enhance plant resilience directly. Advances in genome editing provide an unprecedented opportunity to develop varieties better suited to future environmental and agronomic conditions.
Our ongoing collaboration with the Fondazione Edmund Mach (F.E.M.) over the past three years exemplifies how targeted genetic improvement can be leveraged to address these challenges. By integrating cutting-edge biotechnology with practical viticultural knowledge, we aim to reshape the behavior of grapevines to ensure sustainable wine production in a rapidly changing world.

Brief CV:

Olivier Zekri is a French agronomist specializing in plant biotechnology applied to viticulture. For nearly 20 years, he has been working with Pépinières Mercier, a leading player in the winegrowing sector, where he currently serves as Head of R&D. He oversees the NOVATECH laboratory and leads several breeding programs focused on developing new grapevine varieties that are disease-resistant and better suited to climate challenges and input reduction. He is also actively involved in international projects, particularly in Europe and South America

Fabio Fiorani

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Title of the presentation:
Integration of root-specific traits into resilient crop ideotypes

Abstract:

Definition of crop ideotypes for enhanced (water and nutrient) resource use efficiency has primarily focused on functional studies of leaf and shoot function. Accordingly, many studies have addressed the effect of individual or combined stresses (e.g., water and temperature) on photosynthetic performance and stomatal regulation. In this context, ideotypes (i.e., water savers and water spenders) with a potential for specifically adapting to a range of environments from semi-arid to continental climate, have been defined, notably for major cereals. Whereas some root traits may have been partly co-selected in crop breeding, research on potentially useful below-ground has been hampered by a limited availability of phenotyping methodologies. However, significant steps forward were achieved in recent years to address this issue. Conducting root research also at a relatively large scale has become more feasible, which allows to explore crop genetic diversity in potentially useful architectural and anatomical root traits for a direct application in pre-breeding programs. In this presentation, I will first focus on selected case-studies addressing photosynthetic and water relations traits in limiting environments. Second, I will showcase some of the new possibilities offered by novel phenotyping methods and platforms (controlled environment and field) for the morpho-physiological characterization of root systems applicable to a range of species including grapevine. Finally, I will give examples of potentially useful root traits emerging from this type of research.

Brief CV:

I received the B.S. degree in agricultural sciences from the University of Milan, Italy, and the Ph.D. degree in plant ecophysiology from the University of Utrecht, The Netherlands. I held post-doctoral positions at Duke University, NC, USA, and at the Flemish Institute of Biotechnology, Plant Systems Biology, Ghent, Belgium, from 2001 to 2007. From 2007 to 2010, I was a Senior Scientist with Crop Design, BASF Plant Science in Ghent, Belgium. Since 2010, I led a multi-disciplinary group at the Institute of Plant Sciences (Jülich Plant Phenotyping Center - JPPC), Forschungszentrum Jülich, focusing on development and application of screening methods for quantifying plant growth dynamics nondestructively. I currently continue research on plant acclimation to environmental stresses as a senior scientist at FZJ-IBG-2 in the JPPC research group.

Massimo Galbiati

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Title of the presentation:
Exploiting the transcriptional control of stomatal activity for plant water productivity and drought resistance

Abstract:

Several of the manifold interactions between plants and their surrounding environment are modulated by stomata. Tuning of stomatal aperture relies on the coordination of a complex network of signaling pathways, mostly activated by plant hormones. Despite the well-established role of abscisic acid (ABA) and jasmonates (JAs) in mediating stomatal closure in response to water stress, other molecules are emerging as additional components of stomatal regulation. Increasing evidence indicates that the oxylipin 12-oxo-phytodienoic acid (12-OPDA) is an active signalling molecule, besides being a JA metabolic intermediate. We investigated the role of the AtMYB60 transcription factor in regulating oxylipin synthesis in stomata. AtMYB60 is expressed in guard cells under optimal growth conditions, whereas its transcript abundance rapidly declines following exposure to drought or ABA. Loss of AtMYB60 function in the atmyb60-1 allele, results in constitutively reduced stomatal opening and increased drought resistance. We uncovered increased levels of 12-OPDA, JA and Arabidopsides in guard cells purified from the atmyb60-1 mutant compared with the wild type. Genetic and physiological analyses indicated that 12-OPDA triggered stomatal closure independently of JA and cooperatively with ABA in atmyb60- 1. Considering the strong conservation of the AtMYB60 regulatory network between Arabidopsis and distantly related species, including tobacco, tomato and grape, engineering of the AtMYB60- dependent oxylipin biosynthetic pathway could provide an attractive strategy to enhancing crop survival and productivity under stress.

Brief CV:

Massimo Galbiati obtained his master's degree in Agricultural Sciences from the University of Milan, Italy, and subsequently his Ph.D. in Plant Biology and Crop Productivity at the same institution. He held a postdoctoral position at the Department of Molecular, Cellular and Developmental Biology, Yale University, New Haven (CT), USA, from 1994 to 1998. From 2000 to 2020, he held the position of Laboratory Manager at the Department of Life Sciences, University of Milan, Italy. Since 2020, he has been working as a Senior Research Scientist at the Institute of Agricultural Biology and Biotechnology (IBBA), National Research Council (CNR), Milan, Italy. His research interests are mainly focused on ABA signaling and stomatal regulation mechanisms activated by abiotic stress.

Tracy Lawson

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Title of the presentation:
Manipulating Stomatal Response to Improve Water Use efficiency

Abstract:

In order for leaf photosynthesis to take place CO2 must enter the leaf through adjustable pores, called stomata, and at the same time water is lost through these pores which also aids in cooling of the leaf. As stomatal behaviour controls photosynthesis, water loss and leaf temperature these pores are an unexploited but important target for manipulation to improve crop productivity. As a strategy to improve both carbon assimilation and water use we are exploring the speed of stomatal responses to changes in environmental signals. It is clear that stomatal responses that are rapid and in tune with mesophyll demands for CO2 have greater A and water use efficiency. Exploring a range of different sorghum cultivars, we demonstrated an extremely tight coupling between A and high water use efficiency. Stomata open in response to increasing light and depending on the wavelength of light two different responses have been identified. The first is named the “red” light or mesophyll response, occurs at high light levels and is linked directly to the rate of photosynthesis. The second is the “specific blue” light response, which occurs and is saturated at light levels too low to drive photosynthesis. Here we explore the potential to reduce the stomatal blue light response to improve water use efficiency in key crops including wheat. These results will feed directly into current breeding pipelines.

Brief CV:

Professor Tracy Lawson is a professor in Plant Physiology with over 30 years’ experience in photosynthesis and stomatal research. She obtained her first degree in Applied Biology in 1993 from Liverpool and PhD from Dundee in 1997. She has recently moved from the University of Essex to take up a position at the University of Illinois, USA. Prior to her move Tracy was at Essex for 26 years, and established the Essex Plant Innovation Centre, and recently developed STEPS (Smart Technology Experimental Plant Suite) a state-of-the-art growth facility and phenotyping platform, as well as being Head of Plant Group for 6 years. Her research focuses on the stomatal control of atmospheric gas entry into the leaf, associated water loss and the mechanisms that regulate this process. Recent research has paid particular attention to stomatal kinetics and the impact of dynamic environments on both photosynthesis and stomatal behaviour. Tracy’s work also concentrates on phenotyping including chlorophyll fluorescence techniques (for quantifying light use and photosynthetic efficiency) and thermal imaging (for measuring stomatal responses and kinetics). Lawson’s lab developed the first imaging system for screening plant water-use-efficiency (McAusland et al., 2013).

Simon Josef Unterholzner

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Title of the presentation:
Unveiling the link between energy availability and drought stress response in the Arabidopsis root

Abstract:

In plants photosynthesis builds the basis for all renewable organic carbon and oxygen sustaining human life and ecosystems on earth. Photosynthetic products are transported from source tissues to sink tissues. Plants' adaptation of growth and development to the environment, and hence available photosynthetic products, needs to be integrated continuously as new organs are formed, especially under abiotic stress, such as low water availability. This unique capability relays on meristems, a group of pluripotent, dividing cells originating from stem cells residing in a stem cell niche. In the root meristem, functionally distinct tissues are concentric organized with outer protective cell layers and vascular bundles, connecting root and shoots for long-distance water, nutrient and carbohydrate exchange. Lineage intrinsic developmental programs, as well as a continuous exchange of information with neighboring cells, guide tissue maturation form cell proliferation zone to the transition zone, where cells start to differentiate. Because cell divisions are energy consuming, meristem activity depends on energy supply from photosynthetic active leaves and stems. Under water stress conditions, ABA repress meristem activity at least in part by directly inhibiting the key metabolic signaling network mediated by TARGET OF RAPAMYCIN (TOR). Inhibition of TOR activity favors stem cell quiescence and differentiation of most meristematic cells. However, in meristems a few cells close to the quiescence center are maintained, likely by favorizing sink strength of meristems over other organs, and once TOR activity resumes these cells re-activate cell divisions to sustain plant growth. Here we present data that suggest a role for two cell-to-cell mobile transcription factors to link energy signaling with energy supply to root stem cells under low TOR activity and high ABA.

Brief CV:

He obtained his master's degree in international Horticultural Science at the Technical University of Munich, School of Life Sciences, Germany in 2012 and in 2017 his PhD at the same University. From 2017 to 2019 he worked as a postdoctoral researcher at the Department of Biology and Biotechnology "Charles Darwin" (BBCD), University La Sapienza, Italy and from 2019 to 2022 at the Faculty of Science and Technology, Libera University di Bolzano, Italy. Since 2022 he is a researcher in Agricultural Genetics at the Faculty of Agricultural, Environmental and Food Sciences, Libera University di Bolzano, Italy. He is interested in uncovering genetic pathways that control agricultural traits that confer developmental plasticity to the environment. His current research focuses on understanding how metabolic signals are sensed at the root tip level and how cell-to-cell communication can translate molecular signals to reprogramme the development of the whole root system.