CroP-BioDiv
ZNANSTVENI CENTAR IZVRSNOSTI ZA BIORAZNOLIKOST I MOLEKULARNO OPLEMENJIVANJE BILJA
CENTRE OF EXCELLENCE FOR BIODIVERSITY AND MOLECULAR PLANT BREEDING

Svetošimunska cesta 25, HR-10000 Zagreb, e-mail: coebiodiv@agr.hr, web: biodiv.iptpo.hr

WORKSHOP

High-throughput plant phenotyping

28-29 October 2021, Zagreb, Croatia

Organized by

COE CroP-BioDiv – 'Biodiversity and Molecular Plant Breeding'

KK.01.1.1.01.0005

ORGANIZING COMMITTEE:

Klaudija Carović-Stanko
Boris Lazarević
Hrvoje Šarčević

INVITED LECTURERS:

Andreas Hund
Department of Environmental Systems Science, ETH Zürich

Craig Sturrock
Hounsfield Facility, School of Biosciences, University of Nottingham, UK

Dominik Vodnik
Department of Agronomy Biotechnical Faculty, University of Ljubljana, Slovenia

Marek Živčák
Department of Plant Physiology, Slovak University of Agriculture, Slovakia

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WORKSHOP PROGRAMME:

Thursday, October 28, 2021 :: 9:00 :: Chamber Hall / ZOOM

Join Zoom Meeting

https://us02web.zoom.us/j/82917734034?pwd=ZnFYdDhQWjY0UWVibVovcXVwOWxPUT09

Meeting ID: 829 1773 4034

Passcode: 955322

Workshop foreword :: 9:00
Zlatko Šatović - Presentation of Center of excellence for biodiversity and molecular plant breeding
Boris Lazarević - Workshop programme and lecturer presentation

Lecture 1 :: 9:15

Marek ŽIVČÁK - Chlorophyll fluorescence methods and protocols for application in plant phenotyping

Lecture 2 :: 10:00

Andreas HUND - Field Phenotyping

Lecture 3 :: 11:00

Craig STURROCK - Multiscale Imaging for Plant Root Phenotyping

Laboratory :: 12:00

Boris Lazarević – Root phenotyping examples

Lunch :: 13:00

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Friday, October 29, 2021 :: 8:00 :: Lecture Hall I/1 / ZOOM + Plant Phenotyping Laboratory

Lecture :: 8:00

Dominik VODNIK - Measurements of the gas exchange of plant leaves - an efficient application of open IRGA measuring systems

Lecture and Laboratory :: 9:00

Boris LAZAREVIĆ – Chlorophyll fluorescence measurements, gas exchange measurements, multispectral measurements

Lunch :: 12:00

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Marek Živčák - Chlorophyll fluorescence methods and protocols for application in plant phenotyping

Chlorophyll fluorescence analysis represents a tool for non-invasive detection of the state and function of photosynthetic apparatus in plants. Thanks to the rapidity and availability of the devices, chlorophyll fluorescence techniques became widespread and used in a broad range of various applications. The lecture presents the basic chlorophyll fluorescence phenomena, basic classification of the methods and principles of the most important chlorophyll fluorescence methods used in plant diagnostics. In the pulse amplitude modulated (PAM) method, the primary attention is on the saturation pulse method and parameters characterizing partitioning of absorbed light energy and their physiological interpretation and links to main photosynthetic processes. The second technique presented represents the record of fast fluorescence transient and its analysis using the JIP-test. Basic principles, advantages, and disadvantages of the method are presented, together with examples of application in plants exposed to various stress effects. The information provided by the main parameters is discussed, and the main limits are identified. The third technique with a high potential in crop studies is the spectrally induced fluorescence technique with the fluorescence excitation ratio analyses applied. Unlike the previous method, this technique enables detecting changes in leaf optical properties given by the presence or concentration of pigments in aboveground parts of plants. In addition, the technical innovations and technological improvements are presented, including the application of fluorescence methods in parallel with other techniques and chlorophyll fluorescence imaging applications. In connection to the information presented, the topic of crop phenotyping and requirements for the methods applied in high-throughput systems are briefly introduced. Recent applications and perspectives of chlorophyll fluorescence methods in crop phenotyping are discussed, including possibilities of automatization and robotization of data capture and analysis.

Andreas Hund - Field Phenotyping

High-throughput field phenotyping methodologies hold great promise to improve the genetic gain of yield and yield stability. It will help researchers and breeders to quantify relevant traits in a reliable and automatic manner saving a lot of man hours in the field. But it will also enable to follow the crops throughout the growing season to elucidate which environmental factors or management measures lead to a differential plant response. The young discipline profits form new sensing technologies, as well as the development in robotics and machine learning. The latter is an indispensable means to enhance the feature extraction form all sorts of images and hyperspectral data. Once features are extracted (e.g. canopy cover, height, or greenness; numbers of plants, ears or tillers) further modelling steps are required to determine treatment-specific response pattern. The lecture will give a summary of the required steps to quantify such response pattern during plant development in the field.

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Craig Sturrock - Multiscale Imaging for Plant Root Phenotyping

Understanding how plants respond to unfavorable environmental conditions can have many benefits to crop breeding programmes by the identification and selection of adaptive traits that confer stress resilience. Imaging based phenotyping methods are useful to collect spatial and temporal information on both above and below ground components of plants. The Hounsfield Facility at University of Nottingham, brings together a series of multiscale imaging platforms to capture the structure of plant roots, leaves and canopies. The Facility has three X-ray Computed Tomography systems which allow detailed information of the 3D shape of the roots systems and how the develop over time to stress with the goal to discover resilience traits for the plant. To complement this technology, Laser Ablation Tomography allows imaging of anatomical scale traits. My talk will provide examples of how our work using X-ray CT and laser Ablation Tomography at The Hounsfield Facility can provide insights into the influence of biotic and abiotic factors on both root system architecture and soil structural development and their importance for sustainable crop production for the future.

Dominik Vodnik - Measurements of the gas exchange of plant leaves - an efficient application of open IRGA measuring systems

This presentation introduces basic concepts for portable open-flow gas exchange systems where CO2 and H2O are measured simultaneously with IRGAs. Protocols for measuring stomatal conductance, transpiration, net photosynthesis, and respiration will be presented and discussed. The environmental factors affecting these processes and the control and management of these factors during measurements are explained. Measurements of photosynthetic light response and CO2 response curves are presented, as well as the combined use of photosynthetic measurement systems with a built-in fluorometer and fast-response portable porometer.

Boris Lazarević - Laboratory - root phenotyping

Root architecture and its developmental plasticity are key factors in acquisition resources from the soil (such as water and plant nutrients). Thus, analysis of root traits can provide important information about plant performance under different soil constraints. Simple laboratory experiments for root morphology analysis

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will be presented - hydroponics, pouches, mesocosms. Root imaging and scanning techniques and the examples of image processing and analysis will be shown.

Laboratory – multispectral scanning

Multispectral scanning could be used for morphological and physiological analysis of aboveground plant organs, from cell level to the canopy level. Light reflectance at different wavelengths gives us insight into plant physical and biochemical properties. We will use PlantEye F500 3D multispectral scanner (Phenospex, Heerlen, Netherlands) for the quantification of plant morphological traits such as leaf area, plant height, biomass etc., as well as for the calculation of different vegetation indices such as NDVI, PSRI, NPCI etc.

Laboratory – chlorophyll fluorescence imaging

Chlorophyll fluorescence imaging is widely used advanced technique for detection and quantification of plant stress. This technique enables the estimation of the plant's photochemical efficiency. The demonstration of the chlorophyll fluorescence imaging and analysis of chlorophyll fluorescence parameters will be performed by CropReporter (PhenoVation B.V., Wageningen, Netherlands).

Laboratory – gas exchange

Gas exchange analysis is a cornerstone of all ecophysiological research. These measurements can give insights into plants primary metabolism such as photosynthesis, transpiration, respiration, photorespiration, etc. Examples of different measurements will be done using LI-6800 (Li-Cor, Lincoln Nebraska, USA).

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