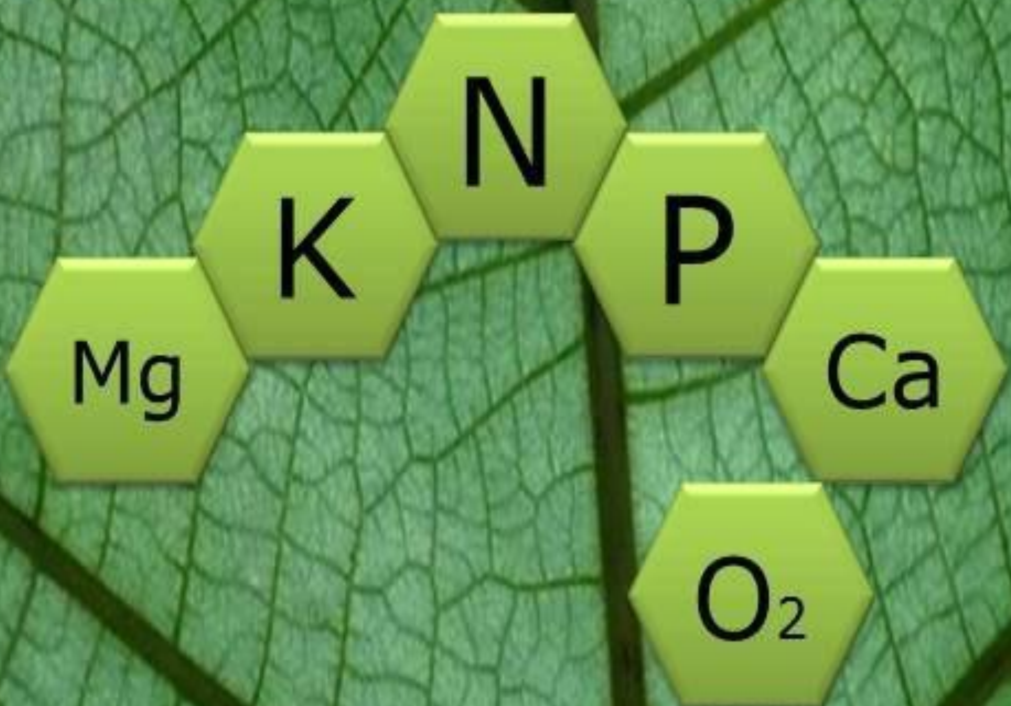
VISCEA
Vienna International Science Conferences and Events Association

International Conference

Plant Nutrition, Growth & Environment Interaction IV



Programme & Abstracts

Vienna, Austria
February 24-25 , 2020

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Organizing Committee

Local Organizing Committee	International Organizing Committee
Alisher Touraev (Local Organizer, Austria) Karl H. Mühling (Conference Co-Chair, Germany)	Marta Vasconcelos (Portugal) Saad Sulieman (Sudan) Sylvia Schnell (Germany) Vit Gloser (Czech Republic) Stefanie Wienkoop (Austria) Edgar Peiter (Germany) Christoph-Martin Geilfus (Germany) Ricardo Giehl (Germany) Malcolm Hawkesford (United Kingdom) Hermann Jungkunst (Germany)

Welcome to the 4th International Conference on "Plant Nutrition, Growth & Environment Interaction"!

Efficient plant production and yield is highly dependent on understanding of the basic principles underlying the three-way interaction between the plant development, its nutrition and its interaction with environment.

The **4th International Conference "Plant Nutrition, Growth and Environment Interaction"** to be held on **February 24-25**, **2020 in Vienna Austria** will review the state of the art and progress in the knowledge of plant growth, plant responses to nutrition and environment and to set research priorities for the next era of research. The Conference program covers a broad spectrum of topics from plant growth, development and nutrition to plant – environment interactions.

This two-days event will provide leading academy and industry scientists a platform to communicate recent advances in "**Plant Nutrition, Growth and Environment Interaction**", and an opportunity to establish multilateral collaboration.

The **4th International Conference on "Plant Nutrition, Growth and Environment Interaction"** will cover the following research topics:

- ***Plant-Microorganism Interactions***
- ***Nutrient Availability in Soils, Toxicity & Remediation***
- ***Nutrient Uptake, Transport & Homeostasis***
- ***Nutrient Functions in Plants***
- ***Plant Nutrition, Crop Productivity & Food Quality***

Approximately 150 participants are expected to attend this exciting scientific forum including almost 30 lectures delivered by worldwide known invited speakers and young, talented speakers selected from submitted abstracts. The program combines plenary lectures, poster sessions, a unique Conference Dinner Party and sightseeing tours of Vienna.

Prof. Alisher Touraev (VISCEA, Austria, Local Organizer)

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4th International Conference on "Plant Nutrition, Growth & Environment Interaction" (February 24 - 25)

February 24 (Monday)

08.00 - 17.00	***Registration***
09.00 - 09.20	**Opening** Welcome address by **Alisher Touraev (Local Organizer, Austria)** Welcome address by **Karl H. Mühling (Conference Co-Chair, Germany)**
09.20 - 10.30	**Keynote Lecture:** **Marta Vasconcelos (Portugal):** The Journey of Iron Nutrition: Lesson's from the Past, Present and Future
10.30 - 11.00	***Coffee break***
11.00 - 12.30:	**Session I: Plant-Microorganism Interactions**
Chairs	*Saad Sulieman (Sudan) & Sylvia Schnell (Germany)*
11.00 - 11.30 (+5)	**Saad Sulieman (Sudan):** Metabolic Acclimations to Phosphate Stress by N2-Fixing Legumes
11.35 - 11.55 (+5)	**Sylvia Schnell (Germany):** Mitigation of Salt Stress in Summer Barley by the Plant Growth-Promoting Actions of Hartmannibacter diazotrophicus
12.00 - 12.10 (+5)	**Pawel Bednarek (Poland):** Metabolomic Approaches reveal the Impact of Growth Promoting Fungal Endophytes on Arabidopsis Metabolom
12.15 - 12.25 (+5)	**Flavio Anastasia (Italy):** Effects of the Phosphatic Nutrition on Growth Parameters and Artemisinin Production in A. annua Plants inoculated or not with Arbuscular mycorrhizal fungi
12.30 - 14.00	***Lunch + Poster Session (all numbers), Conference Photo***
14.00 - 15.30	**Session II: Nutrient Availability in Soils, Toxicity & Remediation**
Chairs	*Karl H. Mühling (Germany) & Vit Gloser (Czech Republic)*
14.00 - 14.35 (+5)	**Karl H. Mühling (Germany):** Measures for Increasing Manganese Availability in Soils by Mineral and Organic Fertilization
14.40 - 15.10 (+5)	**Vit Gloser (Czech Republic):** Nutrient Availability and Water Transport in Plants
15.10 - 15.25 (+5)	**Julie Leroy (France):** Assessment of Nitrogen Fluxes in Miscanthus
15.30 - 16.00	***Coffee break***
16.00 - 17.40	**Session III: Nutrient Uptake, Transport & Homeostasis**
Chairs	*Stefanie Wienkoop (Austria) & Edgar Peiter (Germany)*
16.00 - 16.30 (+5)	**Stefanie Wienkoop (Austria):** Sulfur Transport and Metabolism in Legume Root Nodules
16.35 - 17.05 (+5)	**Edgar Peiter (Germany):** Manganese in Plants: From Acquisition to Subcellular Allocation
17.10 - 17.20 (+5)	**Sara Cimini (Italy):** Redox Homeostasis acts as a Key player of Tolerance against Salt stress in different Rice Cultivars

17.25 - 17.35 (+5)	**André Sradnick (Germany):** A Typological Concept to Predict the Nitrogen Release from Organic Fertilizers in Vegetable Production
17.40 - 19.00	***Welcome Reception + Poster Session (all numbers)***
19.00 - 22.00	**Conference Dinner Party** Traditional Austrian food and wine, located in one of Vienna's famous 'Heurigen' **Cost: 50,- EUR**

February 25 (Tuesday)

08.00 - 17.00	***Registration***
09.00 - 10.30	**Session IV: Nutrient Functions in Plants**
Chairs	*Christoph-Martin Geilfus (Germany) & Ricardo Giehl (Germany)*
09.00 - 09.25 (+5)	**Christoph-Martin Geilfus (Germany):** Function of Chloride in Crop Plants
09.30 - 09.55 (+5)	**Ricardo Giehl (Germany):** Nutrient-Induced Changes in Root Development and Physiology: From Model Plants to Next-Generation Crops
10.00 - 10.15 (+5)	**Jinsheng Zhu (Switzerland):** A Novel Signaling Molecule Controls Plant Phosphate Homeostasis
10.20 - 10.35 (+5)	**Marlena Grzanka (Poland):** Iodine Biofortification of Lettuce with the Use of Iodosalicylates in Pot Experiments
10.40 - 11.00	***Coffee break***
11.00 - 12.30	**Session V: Plant Nutrition, Crop Productivity & Food Quality**
Chairs	*Malcolm Hawkesford (UK) & Hermann Jungkunst (Germany)*
11.00 - 11.25 (+5)	**Malcolm Hawkesford (UK):** High throughput Field Phenotyping Technologies for Monitoring Crop Performance in Response to Nutritional Inputs
11.30 - 11.55 (+5)	**Hermann Jungkunst (Germany):** Plants' Parts in Nitrous Oxide Cycling
12.00 - 12.10 (+5)	**Asif Naeem (Pakistan):** Iodine Biofortification of Food Crops: Recent Advances and Future Challenges
12.15 - 12.25 (+5)	**Dmitry Kechasov (Norway):** Effect of organic Fertilizer on Productivity and Quality of Hydroponically Cultivated Tomato
12.30 - 12.40 (+5)	**Verónica Codesido Sampedro (Spain):** Electrical Conductivity of Nutrient Solution Affects Growth and Biomass Production in an Opposite Way than Secondary Metabolites Synthesis in Cannabis sativa L.
12.45 - 13.00	***Closing Ceremony + Lunch***

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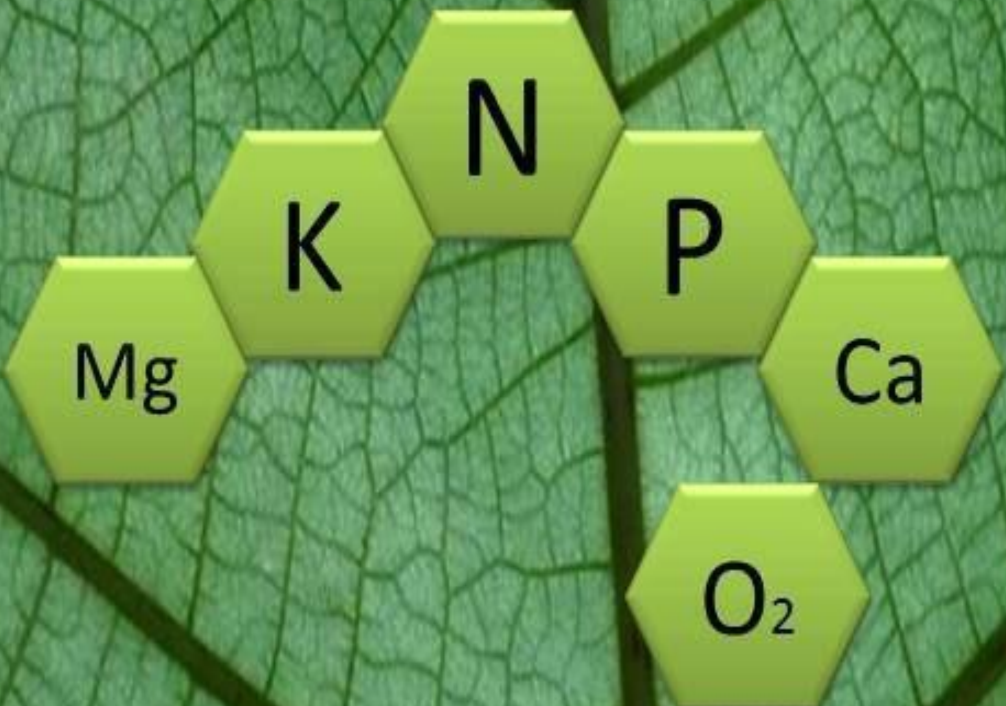
Abstracts of Oral Presentations



The Journey of Iron Nutrition: Lesson's from the Past, Present and Future

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Iron is a co-factor of many vital enzymes and a central component of electron chains. Although it is highly abundant, it exists mainly in the form of insoluble hydroxides which are highly unavailable for plant absorption. Plants must balance iron deficiency and overload, and the mechanisms responsible for iron uptake, transport, and storage, when compared to other minerals, are relatively well understood. However, despite substantial efforts in the research on pant iron nutrition over the past decades, many aspects of cellular iron homeostasis present avenues yet to be explored. Also, iron biofortification efforts have stalled in recent years. Dietary iron deficiency continues to represent a worldwide public health problem affecting more than two billion people, but reaching the desired levels of iron is still a challenging endeavor. A multitude of regulators control iron metabolism, and integrating this knowledge is key. Especially now, when ample evidence suggests that climate change is also diminishing the levels of iron in many plant foods, a race is on to identify the best strategies that can sustainably increase (or at least maintain) the nutritional status iron in plant foods. New technologies bring the promise of faster results, but the regulatory frameworks are still not in place for wider adoption. In this keynote lecture, the voyage of iron nutrition will be given from a historical perspective, and suggestions for future research avenues will be proposed.

Metabolic acclimations to phosphate stress by N2-fixing legumes

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Low phosphate (Pi) availability is a major abiotic stress that received increasing attention, especially for N2-fixing legumes. This is mainly because legume symbiosis requires a large amount of energetic transformations to sustain nodule formation and functions. Coping with this problem, however, remains a challenge for N2 fixing-legumes, which negatively affect their potential contributions in soil health and sustainable food production. Thus, it has been hypothesized that legume symbioses will be severely affected, especially with the projected depletion in global-Pi reserves (i.e., Pi crisis). Nevertheless, N2-fixing legumes possess different strategies (internal and external) that can assist to cope with the shortage in Pi availability. Thus, we have undertaken numerous research activities that can lead to know-how gained in basic research using the model legume Medicago truncatula and grain crops, such as soybean and chickpea. Using physiological, biochemical and molecular approaches, we were able to demonstrate that the acclimation of symbiotic efficiency under Pi deficiency is resulted from a highly coordinated reprogramming of whole-plant metabolism. To this end, different legumes induce an appropriate cascade of changes in cellular metabolic machinery that remarkably helped legumes to acclimate Pi stress via carbon metabolism, N assimilation (N-type of export), sugars, cellular redox status and secondary metabolism.

Mitigation of Salt Stress in Summer Barley by the Plant Growth-Promoting Actions of Hartmannibacter diazotrophicus

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The recently described genus and species Hartmannibacter diazotrophicus E19T is part of a research project on halotolerant plant growth promoting bacteria isolated from the rhizosphere of Hordeum secalinum and Plantago winteri plants growing in a natural salt meadow in Hesse (1, 3). Strain E19T is able to grow on non-water-soluble PO4 sources, nitrogen free media and showed acetylene-reduction activity; moreover growth on DF medium supplemented with ACC and its respective ACC-deaminase activity was demonstrated in cell suspensions. To test the interaction of strain E19T on barley, seeds of H. vulgare cv. Propino were surface sterilized and inoculated with the bacterium. Non-sterile salt adjusted soil (NaCl 1.75 %) was used for seed germination and 15 days after germination salt concentration was increased to 4.4 % NaCl. Forty-two days grown barley plants inoculated with strain E19T showed significantly increased root (308 %) and shoot (189 %) dry weights, and water content in the root system (378 %) compared to control treatment (E19T dead biomass). Also, root-to-shoot ratio was significantly increased, whereas the root Na+ concentration and root surface sodium uptake in barley plants decreased. Reduction of ethylene emission measured on barley plantlets under salt stress showed positive stress relieving effect of E19T due to its ACC deaminase activity. Roots colonization of E19T under salt stress conditions was revealed with a specifically designed fluorescence in situ hybridization (FISH) probe (2). To gain insights into the genetic base of plant growth promotion and its lifestyle at the rhizosphere under salty conditions, we determined the complete genome sequence of E19T (4). The genome comprises one circular chromosome and one plasmid containing several genes involved in salt adaptation and genes related to plant growth-promoting traits under salt stress. Based on previous experiments, ACC deaminase activity was identified as a main mechanism of E19T to promote plant growth under salt stress. Interestingly, no genes classically reported to encode for ACC deaminase activity are present. In general, the E19T genome provides information to confirm, discover, and better understand many of its previously evaluated traits involved in plant growth promotion under salt stress.

1. Cardinale et al. (2015). Paradox of plant growth promotion potential of rhizobacteria and their actual promotion effect on growth of barley (Hordeum vulgare L.) under salt stress. Microbiological Research, 181, 22–32.
2. Suarez et al. (2015). Plant growth-promoting effects of Hartmannibacter diazotrophicus on summer barley (Hordeum vulgare L.) under salt stress. Applied Soil Ecology, 95, 23–30.
3. Suarez et al. (2014). Hartmannibacter diazotrophicus gen. nov., sp. nov., a novel phosphate-solubilizing and nitrogen-fixing alphaproteobacterium isolated from the rhizosphere of a natural salt meadow plant. International Journal Systematic and Evolutionary Microbiology, 64, 3160–3167.
4. Suarez et al. (2019) Complete Genome Sequence of the Plant Growth-Promoting Bacterium Hartmannibacter diazotrophicus Strain E19T. International Journal of Genomics, https://doi.org/10.1155/2019/7586430

Metabolomic approaches reveal the impact of growth promoting fungal endophytes on Arabidopsis metabolom

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In this study we investigated the impact of colonization of Arabidopsis thaliana roots with eight taxonomically distant endophytic fungi that have either positive or negative impact on plant growth under limited phosphate availability. To this end we applied metabolomics analysis based on combination of liquid chromatography with mass spectrometry (LC-MS). Bioinformatic tools dedicated to processing and statistical analysis of metabolomic data enabled to distinguish hundreds of LC-MS signals differentiating particular fungal strains at phosphate deficient conditions. Most of the significantly affected signals had increased intensity in samples obtained from colonized roots as compared with respective controls. Principal component analysis revealed a clear difference in the impact of growth-promoting and growth-retarding fungi. Processing of the obtained data allowed us to identify signals representing metabolites that were specifically affected in the beneficial, but not in the detrimental, interactions. Further identification of these metabolites may shed light on metabolic reprograming that underpins microbe-induced plant growth promotion under limited phosphate availability.

Effects of the phosphatic nutrition on growth parameters and artemisinin production in A. annua plants inoculated or not with arbuscular mycorrhizal fungi

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Artemisia annua L. is a medicinal plant appreciated for artemisinin production, a molecule used for the treatment of Malaria; however, the natural concentration of artemisinin in planta is very low. Plant nutrition, particularly phosphorus, and arbuscular mycorrhizal fungi (AMF) can affect the plant biomass and the secondary metabolite production. A. annua plants (cv. Anamed), generated by seeds, were cultivated for two months in controlled conditions and grown at three different phosphorus concentrations, in the presence or absence of the AMF Funneliformis mosseae. Variations in the phosphatic nutrition significantly influenced the plant growth parameters, the mycorrhizal colonization, the phosphorus uptake, and the artemisinin concentration, that was inversely proportional to the phosphorus concentration in the substrate. The fungus affected the plant growth parameters, the nutrient uptake, and it significantly lowered the artemisinin concentration in the plants.

Measures for increasing manganese availability in soils by mineral and organic fertilization

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Manganese (Mn) deficiency often becomes a significant yield limiting parameter, particularly on calcareous soils, even though the total soil Mn content is usually sufficient. Although it is known that acidifying mineral N-fertilizers can improve the Mn availability, the reason of this effect is still unknown. Acidification of organic fertilizers e.g. biogas residues (BGR) is a new approach to reduce the ammonia emissions but the effect on Mn availability and uptake by crop plants is not considered yet. Our aim was to investigate the effect of stabilized ammonium fertilizers as a tool to distinguish between physiological- and nitrification-induced acidification. Furthermore, the impact of acidification on chemical composition of biogas residues and the influence of plant growth was examined in pot and field trials. Pot experiments with wheat and one soil incubation experiment treated with different nitrogen forms (CN = calcium nitrate, AN = ammonium nitrate, AS = ammonium sulfate, ATS = ammonium thiosulfate) with and without addition of nitrification inhibitors (DCD, Nitrapyrin, Piadin, DMPP), were conducted to examine the effect on Mn availability in the soil and Mn uptake by the plants at different development stages (EC 31 und 39). Biogas residues were acidified to pH 5.5. Water soluble amounts of nutrients were analyzed and compared with total and soluble nutrients of untreated biogas residues. In an outdoor experiment untreated (pH 8.1) and acidified (pH 5.5) biogas residues were incorporated in soil and maize was grown for 8 weeks. With increasing fertilizer ammonium content, a higher plant Mn uptake was detected. The addition of a nitrification inhibitor resulted in a significantly lower rhizosphere pH compared to the non-stabilized fertilizer and lowered the Mn content of the wheat plants significantly. The usage of different nitrification inhibitors always led to lower Mn contents of wheat. The most striking result to emerge from the experiment using the organic fertilizer BGR is that the Mn concentration of maize fertilized with BGR dramatically decreased and the Mn uptake of BGR was even lower as the unfertilized control plants. This effect could be eliminated efficiently by the acidification of BGR. Mn availability was enhanced by ongoing nitrification process rather than physiological acidification. In relationship to other N forms, ammonium thiosulfate led to the highest Mn availability in bulk soil. Compared to mineral fertilizers, Mn nutrition can be improved by acidification of BGR.

Nutrient availability and water transport in plants

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It is well known that water in soil significantly affects the availability of mineral nutrients and their uptake in the plant. This contribution shows, however, that also the availability of mineral nutrients may seriously alter uptake and transport of water within plant even on a short time scale. It focuses on three main areas of nutrient interaction with plant water transport. First, the uptake and radial transport of water in roots where effects on solute membrane transport dominate. Second, the transport in xylem where the composition of xylem sap may significantly alter the resistance of the long transport path in xylem conduits. Finally third, the effects of individual nutrients and stress signals generated by low nutrient availability on stomata and, hence, on the rate of whole plant transpiration rate. Contribution explains why interactions between the availability of mineral nutrients and water should be considered for a full understanding of the effects of these important yield-limiting environmental factors on plants.

Assessment of nitrogen fluxes in miscanthus

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Miscanthus x giganteus has been recognized as a good candidate for lignocellulosic biomass production, as it combines high productivity with low environmental impacts, making it a promising alternative to depleted fossil resources. This perennial grass stores its nutrients in its belowground parts in the autumn and remobilizes them the following spring to support new stem growth, a recycling mechanism that significantly reduces nitrogen input. Our objective is to assess nitrogen remobilization and storage in miscanthus. A variety of methods have been developed to characterize nitrogen fluxes in miscanthus, based on differences between nitrogen stocks in aboveground or belowground parts at key periods that define remobilization and storage (Himken et al., 1997 ; Strullu at al., 2011). Depending on the method used, our results varied widely, with up to four-fold differences in the estimated amount of remobilized or stored nitrogen. We discuss these methods, and we further aim to enrich them, for instance by accounting for nitrogen from fertilizer found in different parts of the plant, or combine them, to identify a more relevant method to estimate nitrogen fluxes.

Sulfur Transport and Metabolism in Legume Root Nodules

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Sulfur is an indispensable and limiting nutrient for all living organisms and actively taken up and assimilated by plants and many microorganisms via specific sulfate transporters. It is a constituent element of some amino acids, metal cofactors, coenzymes, and secondary metabolites. Consequently, sulfur malnutrition decreases plant growth, photosynthesis, and seed yield in both legumes and non-legumes. In nodulated legumes, sulfur starvation causes additional effects: decrease of nodulation, inhibition of symbiotic nitrogen fixation (SNF), and slowing down of nodule metabolism. Hence, while SNF is able to compensate for nitrogen limitation in soils, it is not able to counterbalance for S-deficiency. In my talk I will explain the nodule specific sulfur transport and metabolism and its importance to SNF.

Manganese in plants: from acquisition to subcellular allocation

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Manganese (Mn) is an important micronutrient for plant growth and development and sustains metabolic roles within different plant cell compartments. The subcellular Mn homeostasis to maintain compartmented Mn-dependent metabolic processes like glycosylation, ROS scavenging, and photosynthesis is mediated by a multitude of transport proteins from diverse gene families. However, Mn deficiency is a serious, widespread plant nutritional disorder in dry, well-aerated and calcareous soils, as well as in soils containing high amounts of organic matter, where bio-availability of Mn can decrease far below the level that is required for normal plant growth. By contrast, Mn toxicity occurs in poorly drained and acidic soils in which high amounts of available Mn accumulates. Consequently, plants have evolved mechanisms to tightly regulate Mn uptake, trafficking, and storage. This talk will provide an overview, with a focus on our recent advances, on the multiple functions of transporters involved in Mn homeostasis, as well as their regulatory mechanisms in the plant's response to different conditions of Mn availability.

Redox homeostasis acts as a key player of tolerance against salt stress in different rice cultivars

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Reactive Oxygen Species (ROS) over-production and redox-homeostasis unbalance can arise as a consequence of plant exposure to adverse environmental conditions. Despite their harmful nature, ROS also acts as signaling molecules involved in response to stress stimuli. A complex and differentiated redox network modulated by several adverse stimuli is responsible for the generation of ROS signature that is pivotal for the activation of homeostatic responses and for guaranteeing plant fitness in resistant species or varieties. Nowadays, adverse climatic factors, such as drought, waves of temperatures far from the optimal ones and soil salinization drastically affects crop growth and productivity worldwide. Rice is one of the most sensitive cereals to abiotic stresses, salinity first. Considering the central role of rice in human diet, the comprehension of its resistance mechanisms represents a crucial area of plant science. In order to reach an advancement of knowledge regarding the signaling pathways triggering defence responses against salt stress two rice varieties showing contrasting salt sensitivity have been investigated. Analysis of key metabolites and related genes/enzymes have been performed on the two varieties subjected to salt stresses of different intensity. An in-depth study centered on ascorbate and glutathione metabolism, cellular redox state and markers of cell viability and death has been carried out over treatment time. These results wish to described ROS signatures and different antioxidative pathways as a part of a complex redox network activated in rice after salt stress exposure in order to draw effective strategies aimed at increasing rice resilience toward salt stress.

A typological concept to predict the nitrogen release from organic fertilizers in vegetable production

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Particularly in vegetable production it is very important to secure the nutrient demands of plants at each state of growth. Several field grown vegetables are known to have a short vegetation period coupled with a high nitrogen demand. If the nutrient need is not covered, there is an increased risk of quality loss which results in products which cannot be sold. A large proportion of plant available nitrogen in most organic fertilizers is present in organic form and has to be converted into inorganic forms by microorganisms. It is already known that the nitrogen release from organic fertilizers depends on several quality attributes like the content of lignin, hemicelluloses or the ratio of organic carbon and organic nitrogen (Janssen 1996; Kumar and Goh 2003; Stadler et al. 2006). However, such relationships are usually present in organic materials that are from the same origin, like manures or slurries. That's why a typological approach based on the ratio of organic carbon and organic nitrogen should give a good prediction of nitrogen release from organic fertilizer (Morvan et al. 2006). This should allow a prediction based on quality indices which are present in farming practice. A big literature research was done to get the nitrogen mineralization properties of more than 30 organic typological fertilizer categories. Afterwards a single kinetic function was used to predict the inorganic nitrogen supply in each category. A stepwise linear model was generated for each category to predict the mineralization rate up to 12 months after fertilizer application, dependent on organic carbon to organic nitrogen ratio. We have now the possibility to predict the nitrogen mineralization or immobilization dependent on fertilizer quality and type. After that the model was implemented in the N-Expert software to improve the prediction of nitrogen release from organic fertilizers and plant residues in vegetable production systems.

Function of Chloride in Crop Plants

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The chloride concentration in the plant determines yield and quality formation for two reasons. First, chloride is a mineral nutrient and deficiencies thereof induce metabolic problems that interfere with growth. However, due to low requirement of most crops, deficiency of chloride hardly appears in the field. Second, excess of chloride, an event that occurs under chloride-salinity, results in severe physiological dysfunctions impairing both quality and yield formation. The chloride ion can affect quality of plant-based products by conferring a salty taste that decreases market appeal of e.g. fruit juices and beverages. However, most of the quality impairments are based on physiological dysfunctions that arise under conditions of chloride-toxicity. Photosynthesis is reduced and yield formation is impaired. However, the plant is able to sense the information about an ongoing chloride stress via apoplastic pH-based mechanisms. Chloride-induced changes in the pH of the apoplast induce stomatal closure. A reduced transpiration reduces uptake of further chloride.

Nutrient-induced changes in root development and physiology: from model plants to next-generation crops

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To cope with fluctuating nutrient availabilities, plants integrate systemic and local nutrient cues into developmental and molecular pathways to modify root morphology and function. By exploiting natural genetic variation, we are unraveling novel mechanisms that coordinate root developmental responses to limited availability of nitrogen (N), including a protein involved with brassinosteroid signaling. We also determined that the cell type-specific expression of the ammonium transporter AMT2;1 responds not only to N availability but also to the N form supplied to plants. With the help of transcriptomics, we uncovered a novel cytochrome protein. The identified gene, named HYP, is a plasma-membrane protein that uses ascorbate to drive P-dependent changes in the root apoplast. Root elongation of a hyp1 mutant is strongly inhibited specifically under low P supply due to severely arrested cell elongation and rapid meristem exhaustion. Finally, besides presenting results from studies carried out with model species, I will also discuss potential strategies to use the gained knowledge to develop future crops harboring traits that make them more resilient to environmental stresses and more efficient in the use of supplied fertilizers.

A novel signaling molecule controls plant phosphate homeostasis

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Inorganic phosphate (Pi) is an growth limiting nutrient for plants. It has been not clear how plants sense Pi deficiency in soil. Our recent finding of a novel signaling molecule controlling cellular Pi homeostasis and Pi starvation response in Arabidopsis provided us a better understanding of Pi sensing. The signaling molecule is a specific inositol pyrophosphate isoform composed of a fully phosphorylated inositol ring containing two pyrophosphate moieties and named as InsP8. InsP8 binds to its cellular receptors, SPX proteins, and triggers their negative regulation of Phosphate Starvation Response (PHR) transcription factors. The deletion of Arabidopsis VIH enzymes, which are responsible for the generation of InsP8, leads to hyperactive PHR, constitutive Pi starvation responses and lethal seedling growth phenotypes. Deletion of PHR rescues vih mutant phenotypes, placing VIH in plant Pi signal transduction cascades. The bifunctional VIH enzymes are able to generate and break-down InsP8 in response to cellular ATP and Pi concentrations. Therefore, changes of cellular ATP and Pi concentrations might be translated into changes of InsP8 levels, allowing plants to maintain Pi homeostasis via the SPX-PHR signaling module.

Iodine biofortification of lettuce with the use of iodosalicylates in pot experiments

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In the literature on plant nutrition or plant biofortification little is known on the possibility of plant uptake of organic forms of iodine. In 2018 and 2019, two independent pot experiments were carried out with lettuce cultivation in a heavy (mineral) soil or peat substrate (organic soil). The plants were fertigated once a week (8 applications in total) with 10 µM solutions of: potassium iodate (KI), 5-iodosalicylic acid (5-ISA) or 3,5-diiodosalicylic acid (3,5-diISA) – with a volume of 100 ml per plant per application. The tested compounds did not affect the biomass of lettuce but significantly increased the iodine content of the lettuce. In both experiments, the application of 5-ISA led to the highest accumulation of iodine in lettuce leaves. Plants grown in mineral soil contained more total iodine than those grown in peat substrate. In agricultural practice, plant biofortification with iodine increases the content of organic iodine compounds in plants such as: iodosalicylates, iodobenzoates and plant-derived thyroid hormone analogs what may have a positive effect on the consumer's organism. The research was financed by the NCN, Poland (grant UMO-2017/25/B/NZ9/00312).

High throughput field phenotyping technologies for monitoring crop performance in response to nutritional inputs

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High precision monitoring of phenotypic traits throughout plant development enables new insights into the genetic control of crop performance and responses to nitrogen inputs. A Cartesian robot (Lemnatec Field Scanalyzer) allows autonomous data collection with high spatial and temporal resolution. A sensor platform is positionable in 3 dimensions at any point within the experimental area and may be programmed for autonomous and continuous operation, with a repositioning accuracy of better than 0.5 cm. The sensing platform houses multiple RGB cameras, a thermal camera, two hyperspectral cameras, a capacity for imaging chlorophyll fluorescence and two laser scanners producing high resolution 3D imagery. A major development is overlaying image data from multiple sensors to aid in spatially-targeted spectral analysis. All image analysis requires feature extraction to measure specific traits and examples will be discussed. Sensors technology and algorithms are being adapted to monitor larger scale field trials using drone-based platforms. The presentation will describe these technologies and applications to agriculture. Specific examples will be a genetic dissection of wheat crop growth, canopy development and maturation in relation to nitrogen inputs, and canopy temperature as an indicator of water use efficiency.

Plants' Parts in Nitrous Oxide Cyling

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Atmospheric concentration of nitrous oxide (N2O), a potent and ozone depleting greenhouse gas (GHG), is increasing ever more. The role of soils, in which microbes are transforming reactive nitrogen to N2O, is well reckognized but not yet fully understood. One reason maybe that the role of plants for atmospheric N2O is underestimated eventhough they were also identified as sources. This talk will summerize latest insights from literature and own experiments on the role of plants emitting and reduncing N2O.

Iodine Biofortification of Food Crops: Recent Advances and Future Challenges

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Iodine is an essential for humans as it is required for functioning of thyroid gland, act as antioxidant and antiproliferative agent to malignant cells. Widespread iodine deficiency leads to a spectrum of clinical and socials issues, known as iodine deficiency disorders (IDDs). The use of iodized salt alone could not eradicate iodine decency and thus suggest the need of complementary approaches. Iodine biofortification of food crops represents an effective strategy to mitigate human iodine deficiency. This review complies current knowledge on the possible fertilizers for iodine supplementation and factors affecting their fate in soil. The mechanisms of iodine uptake, its beneficence and toxicity to plants has been uncovered. The controversies over retention in soil, plant uptake and toxicity, and transfer to edible parts between iodate vs iodate forms been enlighten and comprehensively discussed. An insight into the recent update on iodine biofortification of food crops shows that most of the studies were focused on vegetables/ horticultural crops and recorded a considerable iodine enrichment in edibles. Future research efforts are needed for cereals, which can significantly contribute to daily intake requirement of iodine due to major contribution to daily caloric intake. Since iodine fertilization is not expected to increase yield, incentive for farmers needs incentive to practice iodine biofortification.

Effect of organic fertiliser on productivity and quaility of hydroponically cultivated tomato

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Recycling of waste fractions from farms and greenhouses might reduce environmental pollution. However, recycling of nutrient solution in greenhouse is risky due to danger of disease spread. Nitrification bacteria can be used for aerobic conversion of ammonia to nitrate in organic waste and may function as stable microbial community protecting against pathogen attacks by enhancing induced systemic resistance of plants. We developed a hydroponic cultivation system "Organoponics" allowing growth of tomato plant on organic fertilizer with recirculation of nutrient solution. Liquid by-product of biogass production has been used as organic fertilizer. A moving-bed bioreactor was integrated in the system for aerobic nitrification of ammonia. Influence of fertilizer composition (organic, mineral matching organic, standard mineral) and addition of plant growth promoting bacteria on biomass distribution, tomato fruit quality were investigated. Plants grown on organic fertilizer were more generative with largest root index. They also produced fruits with significantly larger average size along whole cluster. Addition of the bacteria to root rhizosphere improved yield and quality parameters of plants received organic fertilization and negatively affected the same parameters in plants received mineral fertilization.

Electrical conductivity of nutrient solution affects growth and biomass production in an opposite way than secondary metabolites synthesis in Cannabis sativa L.

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This study was conducted to determine which electrical conductivity level (EC) is the most appropriate to obtaining the best crop results (agronomically), regarding plant quality, flower harvest (yield) and metabolite concentration (cannabinoids) in the absence of additives. Moniek cultivar of Cannabis sativa was grown hydroponically on rockwool in controlled conditions indoor rooms under four nutrient solution EC levels (2.3, 3.2, 3.7 or 4.2 dS m-1). The four solutions were adjusted at pH 5.8 and plants were harvested 12 weeks after transplanting. The layout was a randomized complete block design with 24 replicates of single-plant plots per room. At harvest, final height (FH) and fresh weight (FW) were measured. Once flowering began, flower samples were collected once per week per treatment, to be analysed for secondary metabolites. After the drying stage, total (TDW), flowers (FDW), leaves (LDW), and stems (SDW) dry weights of plants were measured. Secondary metabolites were analysed using Gas Chromatography. The best results were obtained for the lowest EC treatment regarding biomass measured for all traits (FH, FW, TDW, SDW, LDW and FDW), whereas the worst results were obtained for the highest EC treatment. Intermediate results were obtained for intermediate EC level treatments without statistical differences between them. Percentage of FDW was close similar between the four treatments, indicating that EC was influencing the growth of the plant but not influencing the flowering process. During flowering phenology, there were almost not differences between treatments with respect to cannabinoids. However, for most cannabinoids, treatment with higher EC showed the highest values in concentration, being the treatment with the lowest EC, the worst one. The lower EC treatment was the best one for biomass traits but the worst for cannabinoids content, whereas the highest EC treatment followed the opposite pattern, being the best for cannabinoids content and the worst for biomass traits. As conclusion, increasing EC decreases biomass traits but increases cannabinoids content.

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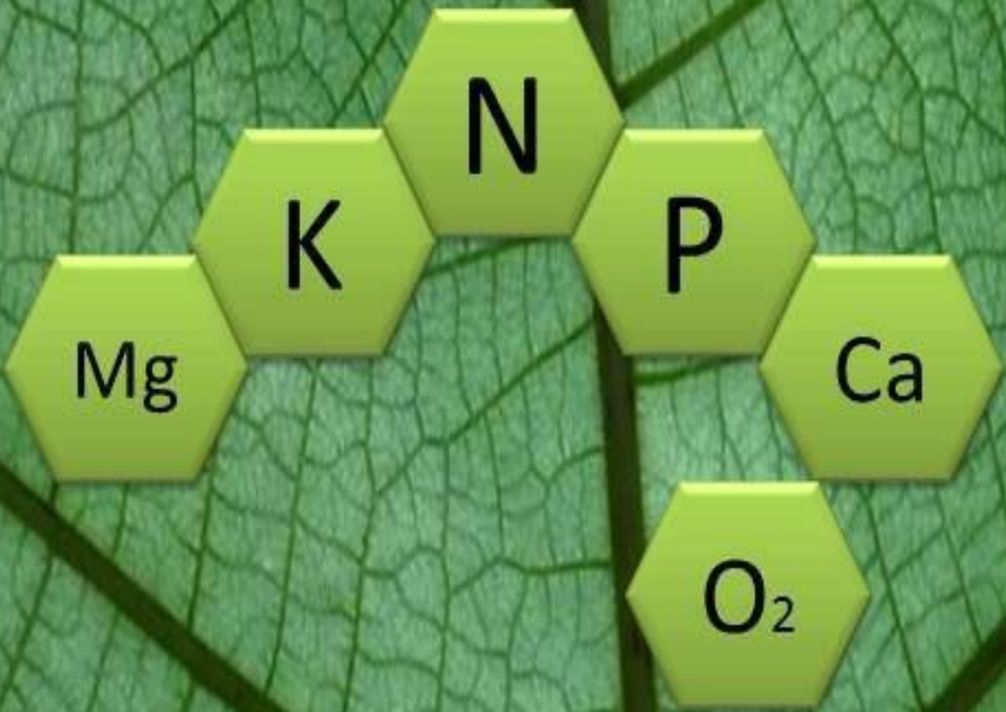
Abstracts of Poster Presentations



Poster №1:

Physiological and ultrastructural effects of thallium on rice seedlings (Oryza sativa, L.)

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Thallium (Ta) is an emerging pollutant compound, which is widely used in the manufacture of electronic components, semiconductors, and optics, thereby have the risk led to environmental pollution. The aim of this study was to explore the toxic effect of Ta on rice seedlings. Growth of rice seedlings on hydroponics containing Ta higher than 1 µM significantly reduced plant height and root length. Histochemical analysis of transgenic rice containing auxin responsive promoter and GUS reporter gene indicating Ta inhibited auxin polar transportation consequently restricted root growth. Ultrastructure of 2-week-old rice seedlings was studied after 5 days culture treating with or without Ta by transmission electron microscopy (TEM). In mitochondria, treating rice seedlings with Ta higher than 10 µM caused swelling in leaves and roots, and 20 µM Ta caused severe collapse of mitochondrial cristae and rupture of outer membrane. In chloroplast, with increasing Ta concentrations the number of plastoglobule increased. To further understand the mechanism of Ta-induced cell death in rice, transcriptomic profiles of roots and shoots response to Ta were analyzed and possible mechanisms will be discussed.

Poster №2:

Hydroponic culture and imaging of root growth in sweet potato (Ipomoea batatas)

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The question we targeted with our hydroponics experiment was: Does light exposure and thus greening of the roots prevent tuber formation in Ipomoea batatas? The initial hypothesis was, that the transformation of amyloplasts into chloroplasts due to illumination prohibits the storage function of the tubers and transforms them from sink organs into source organs. Since hydroponics is a method of growing plants in liquid nutrient solution, it holds the opportunity to get access to the 'hidden' root architecture in a non-invasive manner, without disturbing the architectural arrangement of the roots and observe the growth process in real-time. Therefore, an un-aerated static hydroponic system was built to compare the root growth under dark conditions and under illumination. To monitor the development, a fully automatic camera system was set up and data from environmental sensors were collected. The experiment was run for 70 days with an output of 26 880 pictures and 3360 data points for temperature and light. Unfortunately, the original hypothesis could not be verified because neither the plants of the dark nor the ones of the light regime showed thickened root tubers, but foliage growth was equally abundant under both light regimes.

Poster №3:

Expression, solubilization and purification of PIP1;2-PIP2;5 aquaporin heterotetramers

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Plant development requires effective mechanisms to regulate water and small solute exchange across cell membranes. Such role can be played by membrane protein channels called aquaporins. Structurally, each aquaporin monomer creates a single channel, but these proteins assemble in a functional quaternary structure constituted by four monomers. One family of aquaporins in plants is the Plasma membrane Intrinsic Proteins (PIPs). A peculiar feature of PIPs is their ability to assemble as heterotetramers containing different PIP isoforms. PIPs are further subdivided into two phylogenetic groups, PIP1 and PIP2, demonstrated to physically interact within heterotetramers to regulate their trafficking and the cell membrane permeability. This mechanism has been thoroughly studied in maize using as models PIP1;2 and PIP2;5 isoforms. To better understand the structural impact of such heterotetrameric association leading to the modification of the trafficking and function, we aimed at obtaining three-dimensional structural data. In this work, we optimized the expression and solubilization of PIP1;2-PIP2;5 heterotetramers in the yeast Pichia pastoris and purified these complexes for further structural investigation.

Calcium homeostasis in grapevine and influence in fruit quality

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Calcium supplements have increasingly been used for improving fleshy fruit resistance to abiotic/biotic stress and shelf life. However, the mechanisms that drive Ca2+ transport in the grape berry and its consequences in fruit quality are largely unexplored. In this work, we functionally characterized a CAX-type transporter involved in Ca2+ accumulation in the vacuole of grape cells [1], and assessed the effects of Ca2+ on key enzymes involved in phenolic compound biosynthesis and cell wall organization [2]. Ca2+ affected PAL, STS, DFR and UFGT at transcriptional and protein activity levels, consequently modulating anthocyanin content. The inhibition of polygalacturonase enzymes (PGs) supports the role of Ca2+ in cell wall strengthening.

[1] Martins V et al. (2018) Calcium-and hormone-driven regulation of secondary metabolism and cell wall enzymes in grape berry cells. J Plant Physiol 231, 57-67
[2] Martins V et al. (2017) The grapevine VvCAX3 is a cation/H+ exchanger involved in vacuolar Ca2+ homeostasis. Planta 246(6), 1083-1096

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Reversible of pigment-protein complexes expression pattern and chloroplast morphology during seed development of mung bean

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Pigment-protein complexes are including two light-harvesting complexes, and two photosystems. In legume, seeds have photosynthetic activity before maturity. However, mung bean seeds (including cotyledons, testa and embryo) have different protein expression pattern of pigment-protein complexes and incomplete photosynthetic ability. In cotyledons and embryo, the deficiency of pigment-protein complexes will recover after seed germination and light irradiation, indicating the pigment–protein complexes were fully recovered. On the other hand, testa also has incomplete PSI and PSII pigment–protein complexes, but it can't recover after germination. In addition, the contents of photosynthetic pigments have the same variations with pigment-protein complexes. In morphological study, chloroplasts were lose grana but maintained many layers of thylakoid in testa. Only less than five layers of thylakoid, and large starch grain in chloroplasts of cotyledon. These characterizes are very different with testa. After seeds germination in light condition, chloroplasts were only recovered in cotyledon.

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