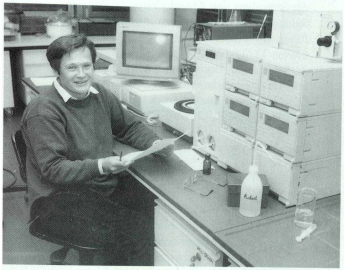
Chemical Plant Physiology

Marianne POPP
o.Univ. Prof., Dr. phil. (University of Vienna 1975)



Research

Stress metabolites in higher plants

One of the main questions in the research of our group is, which chemical and biochemical features enable plants to cope with harsh environmental conditions like salinity, drought and cold. We focus especially on low molecular weight compounds like sugar alcohols, amino acids and quaternary ammonium compounds, which accumulate under stress conditions. Our special interest lies in the group of cyclic polyols (cyclitols), which are widely distributed in the plant kingdom, but generally neglected, perhaps because most of them are commercially not available. During the last years we have isolated and purified a number of these cyclitols, which enables us to make proper quantifications by GC and HPLC, but also to go into their metabolism and way of transport.

Recently, we have identified and characterized enzymes in the biosynthesis of cyclitols such as D-ononitol and D-pinitol. We are now trying to better understand the process of accumulation of cyclitols by monitoring the changes in enzyme activities of key enzymes under stress conditions.

Plant groups we are working with include mangroves, halophytes, and mistletoes as well as herbaceous and woody legumes. Especially in the latter group there are a number of crop plants and species of commercial interest. In cooperation with plant breeding institutions we are trying to find out, if the capacity for high cyclitol storage may be used as a criterion in breeding programmes for drought and salinity resistance.

Tree physiology

Working with mangroves we recognized the paramount importance of the storage of either cyclic or acyclic polyol in this group of plants. In case of mangroves cyclitol storage depends on the salinity the trees are exposed to. However, in a prominent number of tree species in the temperate zone, cyclitols are also the dominating compounds in the neutral fraction of leaves and buds. So far we describe the role of cyclitols in temperate climate trees as "stable organic osmolytes", but future research will focus on their way of functioning.

marpel Checking the way of transport we made detailed investigations of xylem saps of oak, maple and larch. These studies revealed that during the cold season there is a pronounced discrepancy between the total carbon determined and the amount of low molecular weight osmolytes present. At the moment we have some indication that in the case of common maple this difference derives from oligosaccharides present in the xylem sap. Our aim is to find out the complete pattern of organic compounds in the xylem sap of indigenous tree species during the course of the year.

Assimilate transfer and the impact on eco-physiological changes in the rhizosphere

In this field we trace the flow of photosynthetic products into the soil via rhizodeposition by means of HPLC and GC of low molecular weight organic compounds and by soil biological methods such as measuring soil respiration by IRGA and isoenzyme activities.

Since rhizodeposition is highly variable depending on which plant species and soil organisms are involved, we combine a large variety of physiologically interesting plant species and soils to monitor the resulting symbiotic effects. Also, desertification and soil degradation may be understood and fought by exploring soil structure development and its dependency on organic input by plants. Recent procedures for monitoring assimilate transfer and soil microbial activity are evaluated, and more advanced techniques such as ^{13}C steady state labelling, are adapted to fit our aims, i.e. to elucidate the role in source - sink relationships of nitrogen and carbon metabolism.

Teaching

Our courses ("Chemical Plant Physiology" and "Metabolic Plant Physiology") are aiming to introduce students into relevant topics of chemical plant ecophysiology and plant stress physiology including processes in the rhizosphere. We try to combine field work and field collection with analyses in the laboratory and give the students the chance to use up-to-date methods like HPLC with pulsed amperiometric detection and GC-MS. The main lecture on "Plant Metabolism" (4 hours per week during the summer term) presents energy- , carbon- and nitrogen metabolism of higher plants in an evolutionary context.

International Cooperations

Instituto Venezuelano de Investigationes Scientificas, Centro de Ecologia y Ciencias Ambientales, Caracas (Professor Ernesto Medina); - Smithsonian Tropical Research Institute, Balboa, Panama (Professor Klaus Winter); - The University of Queensland, Department of Botany, Brisbane, Australia (Professor George R. Stewart); - Horticultural Research Centre, Marondera, Zimbabwe (Dr. John E. Jackson); - Horticulture Research International, Wellesbourne, Warwick, U.K. (Professor Hamlyn Jones); - Dynamac, National Aeronautics and Space Administration (NASA), Kennedy Space Center, Florida, U.S.A. (Dr. Ross Hinkel)

Selected References

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