Description for the general public

Drought has a detrimental effect on crop cultivation. Each year due to the prolonging periods of water deficit in soil significant loss in yield of economically important crops occurs. Pea is a significant component of our diet but its successful cultivation depends on water availability during the early growth stage and flowering period. Limited water availability results in yield decrease and lower consumption or processing quality of pea. In Poland pea is mainly consumed as canned or frozen form. Breeding strategies of such varieties require detailed understanding of mechanisms responsible for drought tolerance. Studies on drought response in legumes show that pea plants are using drought escape (early varieties having short vegetation period) as well as the drought avoidance strategy. The latter strategy is based on increased water uptake by growing roots or decrease in water transpiration by stomata closing or leaf size decrease (Tabori et al., 2011). Pea plants developed also drought tolerance strategies based on the ability to increase the concentration of osmotically active substances like aldose and ketose molecules being the product of mannitol metabolism. Mannitol and sucrose are major photosynthetic products transported from the sites of synthesis (leaves) to other regions of plant via the phloem tissue.

In this project we are aiming to verify the exact role of the structural and functional changes occurring within the phloem tissue in response to drought stress. We hypothesize that the ability of plant to modify osmotic properties in response to drought correlates with cellular/developmental phloem adjustment and increase in phloem transport. Our work will focus on anatomical and functional changes within the phloem as well as studies on sucrose and mannitol transport. We believe that the involvement of particular sugar loading and unloading proteins is essential in this response.

Due to the fact that phloem encompasses only a small fraction of the total number of cells major problem in studies on sugar metabolism and phloem transport is the collection of defined biological material. All analyses performed on organ fragments can't give the true appraisal of the process occurring in phloem. Here we are planning to use the stylectomy method based on the use of aphids as the tool for precise phloem sap collection. These organisms are capable for precise infestation from phloem sieve tubes. Excised mouth apparatus works as a capillary drain and allows to collect phloem sap for further studies. Samples obtained this way will be used for metabolic profiling of sugars. In order to obtain larger volumes of phloem sap we will use alternative phloem exudate collection method. We are also going to test drought driven expression levels of genes whose products are involved in phloem loading or unloading as well as factors regulating phloem differentiation. For this we will use tissue fragments from various plant areas to understand dynamics of the phloem related processes across the plant. These studies will be supported by anatomical studies of phloem bundles and in situ detection of differentially expressed gene transcripts.

Our project will bring the new evidence on the involvement of phloem in plant adaptive responses to drought. At present functional phloem changes during water deprivation are unknown, therefore our research will help to get true appraisal of drought stress response in plants. Gathered knowledge can help future work on the increase of drought tolerance in pea plants. Our project is an original and multidisciplinary attempt for the complex and holistic description of a basic biological process mediating in plant adaptation to adverse environmental conditions. Project will be carried out by the international research group of the Department of Integrative Plant Biology at the Institute of Plant Genetics of the Polish Academy of Sciences. Due to the complexity of work we will cooperate with metabolomics specialist from the Polish Academy of Sciences Institute of Bioorganic Chemistry.