ABSTRACT

Drought is a global problem that leads to reduction of plant productivity. It affects many economically important crop species including those from the *Fabaceae* family. These species have a special place in the ecosystem due to their ability to form symbiotic relationship with *Rhizobium* and *Bradyrhizobium* bacteria which can fix atmospheric nitrogen. This leads to the increase in readily available form of nitrogen in the soil which can be used by other plants as well. Due to increasing frequency of water shortages in the ground, there is a very high demand for varieties characterized by a wide spectrum of adaptation strategies that allows to maintain high productivity under adverse conditions. Plants have developed large number of strategies increasing their chances of survival under drought conditions. Proper selection of genotypes that use right combination of strategies for a particular cultivation method or location is crucial for successful agriculture. The endogenous mechanisms developed by plants during evolution are very complex and therefore demands in-depth investigation to facilitate proper use of the existing varieties in agriculture. One of the most important facts is that the response to changing environmental conditions requires coordination between distant organs. Vascular tissue certainly participates in such exchange of messages and has the capacity to mediate relocation of certain components involved in osmoregulation or being a source of energy. Based on that we assumed that the composition of phloem exudates reflects physiological status of the plant and thus could be used as a diagnostic measure to identify exact response mechanisms. This hypothesis has been verified by metabolomic analysis of phloem sap supported by parallel studies of physiological parameters like gas exchange, chlorophyll fluorescence or leaf thermoregulation. To obtain a more accurate picture, the data were correlated with measurements of leaf growth dynamics and observations of anatomical changes within the phloem. To deepen our knowledge on trophic issues in pea plants subjected to drought stress, we have quantified the expression of genes involved in loading of sucrose and polyols into the sieve elements.

The above analyses showed that the phloem responds quickly to drought stress by adjusting its anatomy and composition of exudates. Results of the phloem exudate content composition studies point out that drought brings about intensification of numerous catabolic processes in plants helping them to cope with limited energy supply caused by decrease in gas exchange and photosynthesis. Drought also triggers alternative metabolic pathways enabling carbon and

nitrogen remobilization. Moreover, due to the integrative role of the phloem in drought responses, plants activate mechanisms that help to maintain continuity of vascular transport.

Analysis of the metabolite content enabled the identification of compounds that are potential markers of early and late response to drought. We conclude, that changes in the composition of phloem exudates can be used to describe the general physiological responses of plants to drought stress. This also clearly indicates the great potential of vascular sap analysis for monitoring plant responses to adverse environmental conditions