The response of plants to simultaneous biotic and abiotic stress

Plants in their natural environment experience a whole range of stresses. These are various deficiencies, such as water and minerals deficiency, heat, cold, excess light or cases when plant is attacked by diseases or pests. In agriculture, stress causes huge losses inquantity and quality of yield. However, the plants are not defenseless. Over millions of years of evolution in changing environmental conditions, they have developed a number of mechanisms that allow to tolerate stress in a wide range of intensities. The explanation of molecular mechanisms of this specific tug of war is the goal of a number of scientific studies. These studies are especially important for breeding new, more resistant cultivars. To maintain credibility and repeatability, the vast majority of molecular stress research is based on laboratory tests that analyze one factor at a time and narrow range of its intensities. Such studies may have a limited value due to the fact that in the natural environment there are usually multiple variable stress factors. To shed more light on this problem and to bring laboratory results closer to the application, we propose this project, where the biotic stress is represented by attack of parasitic nematodes on roots and abiotic stress – the excessive light applied to leaves.

The main objective of the project is to identify plant genes responding to simultaneous biotic and abiotic stress, that could be used for improvement of resistance to these stresses in crops grown on the field.

The first task will be optimization the experimental setup so that multiple stresses can be repeatedly investigated at an intensity that is harmful indeed to the plant. We will analyze the physiological and molecular responses of two plant species - tomato and *Arabidopsis*. At this stage, molecular analyzes will focus on selected genes whose contribution to other stress responses is well known. This will allow us to plan the main experiment so that we can observe the critical points of the plant's reaction to multiple stresses. As the main task we will perform the widest possible molecular analysis of tomato and *Arabidopsis* gene expression changes by sequencing all transcripts. Genes most responsive to combined stress will be used for more detailed analysis, including testing of *Arabidopsis* plants with mutated versions of particular genes. The planned experiments will highlight two other key issues. Firstly, due to the different application locations of the stress factors, we would like to point out a mechanism of stress information signal flow from the root to the leaf and *vice versa*. Secondly, we would like to explain how the intensity of the stresses affects the reaction of the plant.

Expected results are of great importance for the development of new plant protection methods against parasitic nematodes. Despite identification of numerous plant genes involved in the response to nematodes, little is known on either the method of transmitting information to the aboveground part,on the dependence of the reaction and the degree of plant infestation or severity of environmental conditions. We anticipate that the knowledge of multiple stress response genes can be transferred more efficiently from the laboratory to the field, and that the stress tolerance built with those genes will be more effective in the context of climate change. It should be emphasized that parasitic nematodes cause very severe losses in agriculture and their control is still problematic. These parasites feed on all main crops for food production and renewable fuels: potatoes, sugar beet, corn, soybean and oilseed rape. On the other hand, light stress is a convenient model for studying abiotic stress, both due to the non-invasive nature of its use, the deep evolutionary conservation of its mechanisms and the activation of universal signaling pathways involving plant hormones and reactive oxygen species. We believe that exploring the knowledge on molecular mechanisms of plant responses to nematodes in the proposed way will contribute to widening the repertoire of tools to reduce the detrimental effects of these parasites, particularly considering the potential of new genome editing techniques or the advanced selection of naturally occurring gene variants. In addition, conducting research on two species will allow to find more universal targets for future modifications.