Biophysical and genomic characterization of wound-induced root-to shoot electrical signals.

Plants have the ability to generate electrical signals that rapidly propagate information about stimuli across their body. Electrical signals induced in aerial parts of plants are well described and their molecular mechanism is currently being discovered. Our knowledge about electrical signal in the roots is much more limited. It is still uncertain whether root electrical activity occur commonly and whether root-to-shoot electrical signals have biophysical characteristics and molecular mechanism similar to those observed in aerial parts of plants. Existing information indicates that nematode-induced depolarizations can be transmitted from roots to the leaves where they activate defense processes. Root-to-shoot electrical signals can therefore be practically applied for fast, non-invasive detection of root damage. For this purpose, the comprehensive characterization of root-to-shoot electrical activity and determination of molecular processes regulated by these signals is needed.

Aim of the project
The aim of the project is determination of the biophysical properties (durations, amplitudes, latencies, etc.) of root-to-shoot electrical signals and their effects on gene expression. Collected data will be used to assess the applicability of this type of signaling in the diagnosis of root damage.

Description of research
In the first stage of research a method for repetitive generation of electrical signals in *Arabidopsis thaliana* roots will be developed. As a wounding factor, natural *Arabidopsis* root pests will be used. Then, the characteristics of the root-to-shoot electrical signals will be measured, using the extracellular electrical potential measurements. The impact of this type of electrical signals on plant physiological processes will be assessed based on comparative changes in gene expression between wild type plants and electrical signaling mutants. Traces of electrical signals will then be classified by machine learning algorithm to evaluate use of root-to-shoot electrical signals for automatic detection of root damage.

Justification for undertaking research topics
Increase of the global human population results in fast climate changes on our planet. Therefore, all methods that can be applied for sustainable use of environmental resources, result in reducing the negative impact of mankind on natural ecosystems as well as increasing the quality of people's lives. Discovering new phenomena in scale of individual organism is the basis for development of new diagnostic methods. Root -to-shoot electrical signals are one of the phenomena that can be used to create fast and effective method of diagnosis of underground damage. This would allow for earlier and therefore less intensive treatments of infested plants. This can result in higher crop yields and reduction in the use of pesticides and fertilizers.

Expected effects
Project will gain our knowledge on the occurrence, characteristics and impact of root-to-shoot electrical signals on the physiology and molecular mechanisms of aerial plant parts. The project will create an innovative research methodology that will support future studies of electrical root signaling. Characterization of the gene expression induced by root-to-shoot electrical signals will be the basis for further studies of the molecular aspects of this phenomenon. The use of artificial intelligence for the automatic classification of root signals, will allow for the assessment of their practical application for the early detection of root damage.