Analysis of transcriptomic and physiological changes in leaves of *Brassica napus* L. after the exposure to heavy metals, with particular emphasis on the application of sewage sludge on degraded soils

Contamination of soils with heavy metals is a consistently growing threat to all living organisms. Heavy metals are one of the most common contaminants affecting food safety. Long-term or severe exposure to heavy metals causes the production of toxic, reactive oxygen species (ROS) in the cells, resulting in cellular damage, reduced growth and development, and may lead to the induction of tumor processes in vertebrates. Each organism has some specific defense mechanisms capable of removing ROS and repairing damaged cells. In the event of an imbalance between the quantity of ROS produced and the ability of the cells to remove them and repair the damage, oxidative stress leads to the damage of proteins, lipids, and DNA. Since the problem with soil contamination is increasing throughout the world, the research on the efficiency of remediation technologies is needed, i.e., improvement of the soil quality or of the soil function.

One way to deal with such problem is to use plants to extract contaminants or stabilize them in the soil. Such a process is called phytoremediation. To increase its efficiency, it is beneficial to supplement the degraded soil with different amendments. In recent years, land application of sewage sludge has become a common practice. Such action can improve soil properties and crop productivity and at the same time allows for nutrients reuse from vast quantities of wastewater produced each year. Moreover, these practices can allow to maintain and restore the quality of previously degraded soils, as well as reduce the need for application of synthetic fertilizers.

On the other hand, it needs to be taken into consideration that using sewage sludge as fertilizer also has significant drawbacks. Inadequately processed sewage sludge can have a wide variety of undesired traits and in consequence, adverse effects on a given environment because wastewater contains contaminants which concentrate in sewage sludge Due to this risk, it is crucial to gather knowledge about reducing the hazards associated with using organic wastes such as sewage sludge as soil amendments. Thus, further knowledge on biochemical and physiological responses of plants to stress helps develop new strategies for treatment of contaminated areas and overall improvement of the environment.

The project will focus on the long-term impact of soil supplementation with sewage sludge on transcriptomic changes in plants. Transcriptomic changes correspond to changes in gene expressions. In addition, the physiological effects of soil contamination with heavy metals and supplementation of such soil with sewage sludge in both: lab-made and natural conditions will be assessed based on standard toxicity tests, the activity of antioxidative enzymes, the content of chlorophyll and quantification of DNA damage. An accurate understanding of the ways which enable plants to cope with high concentrations of toxic contaminants and the influence of sewage sludge supplementation on those mechanisms is essential to fully achieve efficient, large-scale remediation operations. The project consists of a first study dealing with the influence of long-term sewage sludge application on plants metabolism with a special focus given on gene expression in order to identify the impacted physiological functions. The study should also delineate the mechanisms in which sewage sludge application on contaminated sites reduces plants oxidative stress and limits the damage caused by metal toxicity. This kind of studies is performed to optimize of the most effective methods of phytoremediation.