Influence of ZnO nanoparticles on the number and biodiversity of plant growth promoting bacteria

The aim of the project is to examine the interaction between the most commonly used ZnO nanoparticles and plant growth promoting bacteria in soil (four types of bacteria— nitrogen fixers, nitrite-oxidizing, phosphate solubilizers, and biofilm formers) through the analysis of: toxicity in laboratory and field conditions, bacterial community diversity, nitrification activity, soil enzyme activity, bacterial and plant biomass.

Nanobiotechnology is one of the fastest developing biotechnology branches and the practical application of nanomaterials is becoming extremely widespread in various technology and industry sectors thanks to their small size as well as their unique properties. Since more and more nanomaterials are being introduced to the European market, it is vital to research their impact on the environment. Despite the obvious benefits of using the nanoparticles (NPs), one needs to take into consideration their possible toxicity that might depend on numerous factors, such as size, aggregation, composition, crystallinity, and surface functionalization. There are several ways through which the nanoparticles could be released to the environment during the production, transportation, use or disposal processes. What is worth mentioning it that there is not enough research on thei impact on soil that is considered a major sink for engineered nanoparticles. Therefore it is important to investigate whether they pose any threat to soil microorganisms (both pathogenic and symbiotic) and, in consequence, to plant growth. The study concentrates on the plant growth promoting bacteria (PGPB), crucial for the agricultural productivity as the replacement for chemical fertilizers. The presence of nanoparticles in soil influences the most basic cellular physiological processes in plants – photosynthesis and oxygen-dependent respiration, thus they create either enhancing or impairing effect on achieving the most optimal conditions for the plant growth and development.

It has been proven that metal-containing NPs are more toxic to living organisms than the organic ones. However, most of the data concerning the NPs' impact on plants or microorganisms-plants interactions comes from the *in vitro* or hydroponic systems studies. Such artificial conditions may change properties of NPs. In soil the behaviour of NPs depends on their distribution in soil pore water, adsorption to mineral and/or organic soil constituents, and the interaction with microorganisms. Therefore, further investigation is necessary for better understanding of that topic.

In this study we evaluate the effect of ZnO NPs on rhizosphere microorganism activity and plant growth by designing experiments in pots with sterile soil inoculated with selected bacterial species and not inoculated. Another matter we cover in this study is examining whether there is a link between the microorganism action and the reduction of NPs size which would influence (either enable or prevent) the incorporation of the NPs into plants. In order to get the results we used a tool that constitutes of the experimental model linked to the plants growing in pots with soil mixed with NPs inoculated or not with selected bacteria. Moreover, in this project we use maize as a plant material to evaluate impact of ZnO NPs-depended rhizosphere microorganisms activity, on plant growth, including basic biochemical processes (photosynthetic rate of shoot part and mitochondrial respiration of roots).

Project is divided into 11 tasks and four milestones and each milestone has a different objective. Milestone 1 focuses on obtaining basic materials and models for further tasks. Milestone 2 provides basic information about biological interaction of tested nanoparticles with plant growth promoting bacteria in soil. Milestone 3 provides information about changes that have occurred in the soil due to the toxicity of nanomaterials to the tested bacteria (metabolism, enzymatic activity, nitrogen cycle). Milestone 4 answers the question: what is the impact of changes in the structure of soil bacteria and their metabolism caused by the addition of NPs on the growth of plants and basic physiological processes (photosynthesis and mitochondrial respiration).