The introduction of nanotechnology into industry opens up enormous opportunities in areas such as health, environment and agriculture, offering innovative solutions to today's challenges. Of particular interest is the use of metal nanoparticles and metal oxides, which show exceptional biocidal properties. However, despite the promising prospects for their use, our knowledge of the long-term environmental impact of nanoparticles remains limited. Understanding their selectivity, mechanisms of interaction with micro-organisms and their impact on ecosystems, especially those associated with agricultural crops, remains a key challenge. This includes their effects on pollinating insects, plants and beneficial mycorrhizal fungi, which are essential for healthy plant and soil functioning.

In response to these challenges, the project focuses on the development of nanoparticles in **natural deep eutectic solvents (NDES)** that have the potential to selectively eliminate pathogenic fungi attacking crops, without negatively impacting beneficial microorganisms such as mycorrhizal fungi, or pollinating insects such as bees. The selective action of such formulations could not only increase the effectiveness of crop protection, but also minimise negative ecological effects, which is crucial for sustainable agriculture.

Research into the selective action of nanoparticles is becoming crucial due to the need to protect the microbial balance in the soil and surrounding environment. Plant-infesting pathogenic fungi pose a serious threat to crop yields, but beneficial fungi such as mycorrhizal fungi, which support plant growth and health, are equally important. Developing nanomaterials capable of precisely destroying only harmful pathogens while preserving the healthful properties of beneficial microorganisms is a challenge of great importance for agriculture. Only with a precision approach will it be possible to provide effective plant protection without disrupting the natural soil microflora and preserving its long-term fertility.

Deep eutectic solvents (DES) are an environmentally friendly alternative to traditional solvents. Created from natural ingredients, they are biodegradable, non-toxic and easy to obtain, making them an ideal carrier for nanoparticles. Their ability to disrupt the structure of the cell walls of micro-organisms enables the nanoparticles to enhance their action, which can therefore better penetrate the cells of pathogens. This combination of nanotechnology and green chemistry can counteract the development of resistance in microorganisms.

The aim of the project is to investigate how suspensions of **metal sulphide nanoparticles** in NDES can effectively weaken fungal cell structures, increasing their elimination efficiency, but in a selective manner. The research will focus on analysing the destruction of pathogenic fungal cells by nanoparticles without destroying beneficial fungi as well as other beneficial organisms. The nanoparticles used belong to the group of plant micronutrients, which will act as a regeneration factor for plants after a disease course. The results of this study may provide answers to the question of whether the use of NDES increases the effectiveness of nanoparticles against pathogens and reduces the risk of resistance formation, as well as eliminating the toxicity of nanoparticles to crop plants and beneficial fungi.

The development of active multifunctional materials based on nanoparticles and NDES opens up new possibilities in plant protection against fungal diseases. This approach may find applications not only in agriculture, but also in the food industry, biomedicine and environmental protection. The project aims to develop cutting-edge solutions that will simultaneously increase the effectiveness of crop protection and ensure the safety of ecosystems. The results will be a valuable contribution to the development of sustainable nanotechnology and may significantly influence the future use of nanomaterials in various economic sectors.