POPULAR SCIENTIFIC ABSTRACT

Aim of the project

This project aims to understand how microorganisms create nanoparticles (NP) of Selenium to develop the most effective method for producing and elaborating practical formulations. This will be achieved by accomplishing three specific objectives. The **first specific objective** is to develop a comprehensive database of microorganisms capable of conducting bioreduction of (Se) compounds. The **second specific objective** is to produce SeNPs with high efficiency. Finally, the **third specific objective** is to formulate SeNP fertilizer preparations that effectively supplement the soil-plant system while ensuring their safe use.

Description of research

The database will contain information on whether the microorganisms can produce Selenium nanoparticles (SeNP) along with their plant growth-promoting properties (PGP). Additionally, the database will include information on their ability to co-exist with other soil microorganisms through consortium studies. These three categories will determine according to which SeNP production scenario microorganisms will be used. The project will test two scenarios for nanoparticle production using the ►*in-situ* production method (bioreduction in soil) and the ►*ex-situ* method (bioreduction under controlled conditions). The microorganisms able to produce SeNP and possess valuable PGP properties will undergo an *in-situ* scenario. The *ex-situ* approach will use microorganisms that do not have PGP capabilities or do not belong to soil organisms, so their use in the *in-situ* method would not be possible due to their low ability to co-exist with other soil microorganisms but show high bioreduction abilities of Selenium compounds.

In each scenario, different methods/products are indicated: ►in the *in-situ* approach, selected for that strategy microorganisms, will be introduced into the soil-plant system in two ways, via (i) plant infestation strategy and (ii) soil inoculation; ►in the *ex-situ* approach, three formulations of utilitarian SeNPs will be evaluated: (i) granules, (ii) gel beads, and (iii) emulsions. Within the *ex-situ* approach, soil (granules and beads) and foliar application (emulsions) formulations of fertilizer preparations will be obtained.

The project will emphasize the proposed **preparations' safety and utilitarian properties.** Much research will be devoted to those issues, including evaluating plants and soil microorganisms' responses at morphologic, agronomic, and physiological levels, including developing an appropriate and safe dose (acute and chronic toxicity, cytotoxicity), etc. The main research objective of this project will be to understand the impact of the microorganism/method used to obtain the NP, produce its utilitarian formulations, and then evaluate its influent on the plant growth environment (soil-plant system), which is a proposal that has not been studied so far.

Ultimately, the SeNP formulations with the highest efficiency will be selected and subjected to pot and field tests. In all research on the soil-plant system, the parameters of the obtained model plants will be taken into account, e.g., ►the volume of the root ball, ►the mass of the green part and ►the chlorophyll content. In addition, ►the elemental composition of plant biomass will also be assessed for possible biofortification with Selenium. There will be a strong emphasis on safety, given the potential toxicity and cytotoxicity of Selenium compounds.

Reasons for taking up this research topic

Intensive exploitation of soil resources in agriculture, combined with improper fertilization, creates a serious risk of nutrient deficiency, including Selenium, in the soil environment. This can lead to a Selenium deficiency in agricultural products, which could result in "silent hunger." Knowing the importance and role of proper nutrition in the soil system, it is necessary to search for new effective ways of introducing Selenium into the soil environment, assessing their effectiveness and safety.

Nanofertilizers are emerging as a promising alternative to sustainable fertilizers, as they have been shown to aid slow nutrient release, increase nutrient use efficiency, and increase abiotic stress tolerance. So far, we know a lot about the positive impact of nanoparticles in plant supplementation. However, more information is needed on the formulations used and in what form the nanoparticles should be introduced into the soil-plant system.

The most important effects expected

The expected effect of this project is understanding the nature of the reduction of Selenium to its nanoparticles by microorganisms and how this process relates to the different elements of the soil system. This understanding will help select the best production method and utilitarian SeNP formulations used for fertilization to ensure high bioreduction efficiency and safety for the soil system while maintaining sustainable agriculture principles. **The expected outcome is a stable fertilizer formulation that will release Selenium slowly and effectively into the soil/plant system, meeting the plant's demand.**