Truffle farming and nanomaterials: a new technology for the optimization of the mycorrhization process and release of "helper" microorganisms

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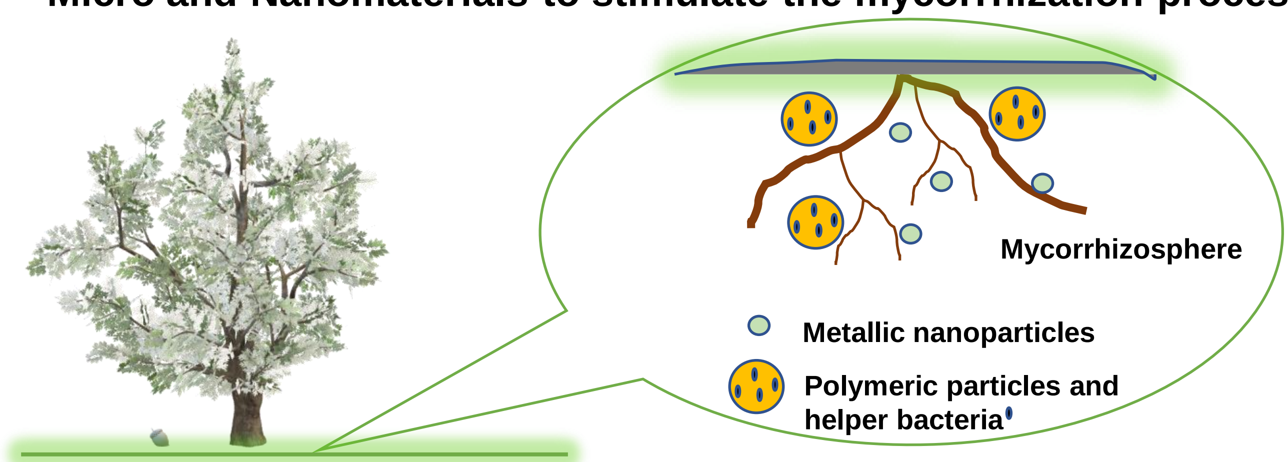
Introduction

Truffle farming is synonymous with specialized plantations where the quality of the starting material, that is the plant with the mycorrhiza, determines its productivity and economic sustainability. The mycorrhizal phase still represents a crucial point in the process and the study of the rhizospheric microbiome in the process of mycorrhizal symbiosis through the action of 'helper' microorganisms is of crucial importance.

The **TANA project** is part of this complex context, in which research groups from the University of Tuscia, Sapienza, in collaboration with the start-up Nanomnia, thanks to funding from LazioInnova regional funding agency for innovation of Regione Lazio, have proposed a new synergistic approach for the enhancement and optimization of truffle farming processes thanks to the combined use of nanotechnologies.

Micro and Nanomaterials to stimulate the mycorrhization process

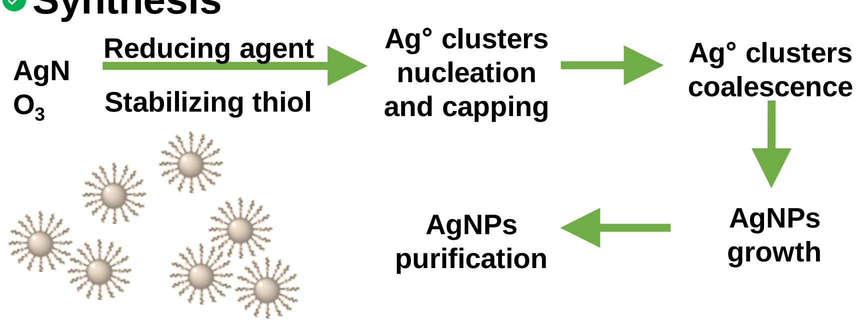


Inorganic compounds, bacteria and viruses contribute to the complexity of the soil biota; among these, bacteria are the most abundant and many of them are classified as MHB (mycorrhiza helper bacteria) because they are able to stimulate the formation of mycorrhizal symbiosis and its vitality.

In this context, nanomaterials can act as carriers for bioactive species and at the same time can be effective in stabilizing and protecting encapsulated molecules / microorganisms (fungi and bacteria), favoring their gradual release into the environment.

Silver Nanoparticles (AgNPs)

Synthesis

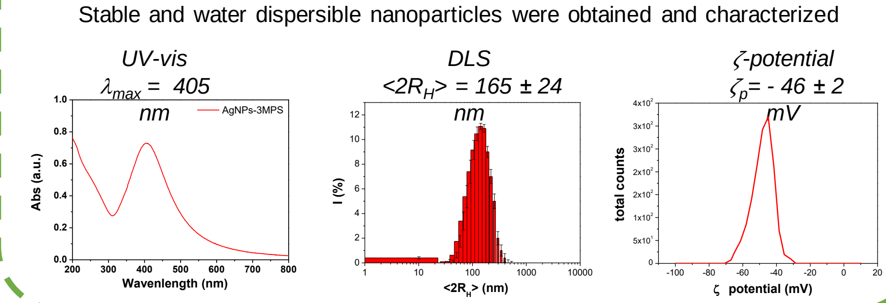


Reducing agent: $NaBH_4$; solvent H_2O_{up}

Stabilizing thiol: Sodium 3-mercaptopropane sulfonate (3MPS)

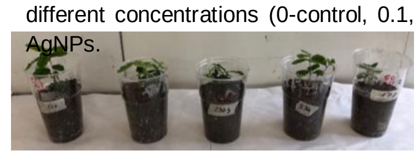
Characterizations

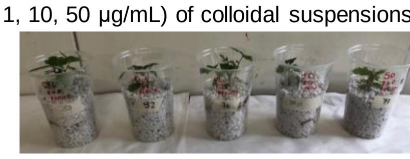
Stable and water dispersible nanoparticles were obtained and characterized



Phytotoxicity studies

- 3-month-old *Quercus pubescens* seedlings were transplanted into biodegradable plastic glasses and supplemented with a ½ Hoagland nutrient solution and five different concentrations (0-control, 0.1, 1, 10, 50 μg/mL) of colloidal suspensions of AgNPs.

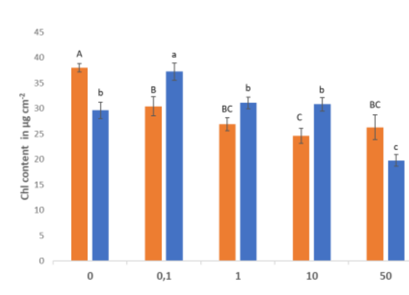




- Perlite and sterile soil substrates were compared, maintaining the seedlings in wet condition, covering the plant with another biodegradable plastic glass and watering once a week, within a controlled growth chamber (16 h light, 8 h dark; 25 °C/23 °C day/night). Visual data at the middle of the experiment showed a more vigorous growth of the aboveground part in the plant material grown into the soil. Elaboration of growth parameters of belowground and aboveground parts are in progress.
- Chlorophyll and other pigments content was monitored by using SPAD (Soil Plant Analytical Development) portable, non-destructive device. In perlite, the presence of AgNPs has a positive effect at concentration 0.1 μg/mL.

  At concentration 50 μg/mL the chlorophyll content decreased compared to the control in both perlite and sterile soil. Regardless of the AgNPs concentration tested, plant growth does not appear to be compromised, even at 50 μg/mL

  Further experiments are in progress at higher AgNPs concentrations.



Chlorophyll content in mature old leaf of *Q.pubescens* plants in soil and perlite. Five different AgNPs concentrations are used (0-control,0.1,1,10 and 50 μg/mL).

Conclusions and perspectives

These preliminary results encourage the study of inorganic nanoparticles and polymer/nanoparticle composites, to be used as carriers of microorganisms in the soil, to improve the rhizosphere formation by providing a consistent source of fungi and bacteria capable of interacting with the root system and the microbiome of the soil. The objective of TANA project is therefore to develop a new biotechnological manufacturing product based on the use of nanotechnologies, functional to the truffle supply chain for *Tuber melanosporum* (precious black truffle) in the process phase that concerns the production of high quality mycorrhized plants, for productive plantations