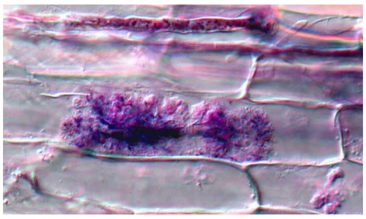
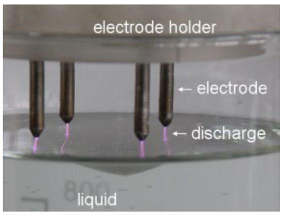
Master thesis project

Engineering the soil microbiome for sustainable crop production through plasma technology





Background

The current, conventional agricultural system relies heavily on the use of mineral fertilizers and chemical plant protection products leading to severe environmental consequences and dependencies on fossil resources. Soil microorganisms have the potential to improve crop nutrition and health in more sustainable ways. Especially the plant-symbiotic arbuscular mycorrhizal fungi (AMF) have been shown to provide a range of benefits to plants. While natural AMF communities are often depleted in crop fields, it has been shown that inoculations of AMF into soils can restore their functions in soil and support crop yields. However, these effects are often context-dependent. While at some sites, the application of AMF brings good results, in other sites it does not. Latest research hints towards a role of the native soil microbiome in determining, whether the addition of external AMF brings the desired benefits, or not.
Plasma technology might offer potential solutions to leverage the conditions that were observed for different sites and to improve the effectivity of AMF inoculations.
Plasma technology can be applied for different purposes to either stimulate or inactivate biological systems depending on generation type and process parameters. When, e.g., high electrical energy is interacting with a medium like air or water, a plasma is induced, providing physical (UV emission, electric fields) and chemical production of reactive species– features that can be used to eliminate harmful microorganisms or organic pollutants. However, this technology could also be used to stimulate the soil microbiome and beneficial microorganisms. The effects of plasma-treated water on the soil microbiome and its potential to stimulate beneficial soil organisms are currently unknown and should be investigated in cooperation with the Leibniz Institute for Plasma Science and Technology (INP). One possible approach could be the application of plasma-treated water (PTW), which could temporarily and locally weaken the native soil microbiome to enable better establishment and improved benefits of inoculated AMF. Additionally, it has been shown that PTW can have direct stimulating effects on specific beneficial microorganisms leading to subsequent effects on crop performance.

Objectives

This project will explore the potential of plasma-treated water as a tool to improve ecosystem functions derived by soil microorganisms. You will first perform greenhouse trials with AMF and other beneficial microorganisms alone and in combination on different soils at Agroscope in Zürich. During a three-month research stay at the Leibniz Institute for Plasma Science and Technology (INP), a research institute specialized on plasma technology in Greifswald, Germany, on the shores of the Baltic Sea, you will perform similar experiments in climate cabinets using plasma technology. You will apply next-generation DNA sequencing methods to analyze effects on soil microbiomes and use classic and molecular tools to quantify AMF in plant roots. Moreover, you will learn to apply plasma technology to produce PTW and to characterize relevant physical and chemical parameters. In this highly novel and interdisciplinary research project, you will learn a unique set of skills and contribute to the development of novel strategies to enhance sustainability in agriculture.

Dates and application

- Starting date: ideally December 2023 or January 2024, with some flexibility
- Duration: 12 months
- the project involves a approx. 3 months research stay at the Leibniz Institute for Plasma Science and Technology (INP) in Greifswald, Germany. An application for a scholarship for a SEMP-Traineeship (Mobility for Higher Education: Swiss-European Mobility Programme (SEMP) | Movetia) would be supported to acquire financial support for the student.

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Relevant literature

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