Bioinoculants as Plants Allies in Phytotechnological Approaches to Soil Requalification

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Introduction

Soil functions and quality have been adversely affected by anthropogenic activities (eg. mining), and the resulting contamination is a serious and crosscutting problem in several countries, including those in the SUDOE territory (Portugal, Spain and France). The urgent need for soil protection and conservation and the development of sustainable technologies to ensure the restoration of their environmental functionalities and services are a priority in European and national research programs and legislation.
The PhytoSUDOE project aims to boost the environmental, economical and social benefits generated trough the implementation of phytotechnologies in degraded sites as a way to encourage their greater use by owners and policy-makers. A transnational network of contaminated sites throughout the SUDOE region (11 sites – Figure 1) was established to demonstrate different strategies.

Figure 1: Site locations

Objectives

The Borralha mine integrates soils with high TE (trace elements) concentrations. Energy crops such as sunflower and poplar can bring economic value to this area. Microorganisms such as mycorrhizal fungi (MF) and plant growth promoting bacteria (PGPR) that stimulate crop growth may benefit these plants by reducing the stress promoted by the contamination. Associated with these plants, agronomic techniques such as intercropping with alfalfa and clover may increase soil organic matter, promoting the biological activity and nutritive status of soils.

The main goal of the work is:

- to evaluate the potential of energy crops cropping systems and the application of microbial consortia in the improvement of the functionalities of soil in the Borralha mine;

Specific objectives include

- improving plant performance and soil functionality/diversity with the use of bioinoculants;
- assess the effect of biostimulants on plant performance and TE mobility and uptake.

Methods

BORRALHA MINE DESCRIPTION AND LOCATION

- Mining exploration started in 1902 with an area of up 1179 ha;
- Composed by 52 concessions (28 (W); 12 (W, Sn); 19 (Sn) and 2 (W, Cu, Ag and Mo).
- Economic exploitation mainly focused on wolframite, scheelite, chalcopyrite;
- Ceased its activity in 1986 without surveillance.
- TE soil concentration (mg kg^{-1}): Cu – 825.2; Cd – 3.9; Co - 14.5; Pb – 92.3; Zn – 138.6; As – 44.3; Ni – 16.9).

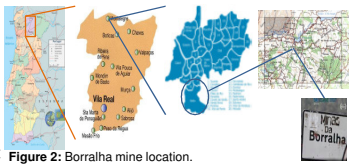


Figure 2: Borralha mine location.

EXPERIMENTAL DESIGN

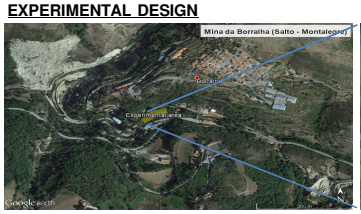


Figure 3: Experimental area in Borralha mine.

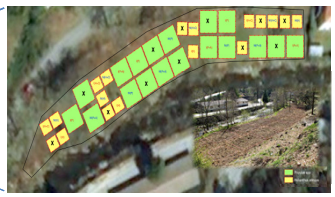


Figure 4: Plots distribution in the experimental area.

Field plots

Experimental surface area	~ 700 m^2
Design of experimental area	4 experimental blocks. Each block is divided into plots of: • 5 x 5 m for Poplar (no cropping pattern and intercropping with alfalfa; inoculated and non-inoculated with MF and PGPR) – Fig. 5 and 6. • 3x3 m for Sunflower (wintercropping and intercropping with clover, inoculated and non-inoculated with Micorrhyzal fungi and PGPR); • 3 plots within each block without cultivation.
Experimental plot size	Each plot: 25 m^2 (x 18) for Poplar 9 m^2 (x 18) for Sunflower (plots without cultivation included)

Schematic view of plots

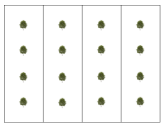


Figure 5: Plot with *Populus* sp..

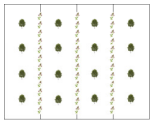


Figure 6: Intercropping system - alfalfa and *Populus* sp..

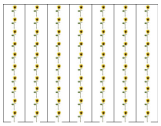


Figure 7: Intercropping system with sunflower and clover.

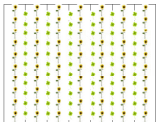
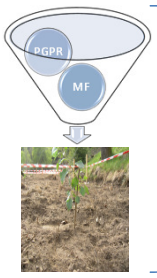
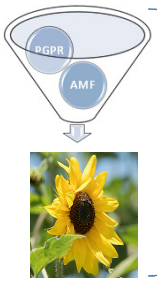


Figure 8: Intercropping system with sunflower and clover.

Microbial Inoculation



Rooted poplars with 1 year inoculated with:
- PGPR (EDP 28) and
- a mixture of AMF and ECM



Sunflower sowed and inoculated with:
- AMF and
- PGPR

Plots establishment/established

Figure 9: Establishment of a plot with *Populus* sp. - removal of the bigger weeds.

Figure 10: Establishment of a plot with intercropping system - sowing alfalfa between *Populus* sp..

Figure 11: Established plot with sunflower after 2 months

On-Going Work

Sunflower was be harvested in October and rhizospheric soil samples will be collected to determine the metal content. Also plant biomass, elongation and metal content in each plant section (root and shoots) will be assessed. Bioconcentration and translocation factors will be determined to assess the plant phytostabilization/phytoextraction abilities.
Soil analysis to determine structural and functional diversity will be performed at the end of the experiment (middle of next year – 2018).
For poplars, height and plant diameter will be evaluated at the end of the experiment.
Rhizosperic samples will be also collected to determine the metal stabilization.

Acknowledgements

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