

PHYTORESTORATION OF A HIGHLY ALKALINE ANTHROPOGENIC SEDIMENT: CONTRIBUTION OF THE EXTRARADICAL MYCELIUM OF ARBUSCULAR MYCORRHIZAL FUNGI

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Introduction

Soil degradation constitutes a major worldwide problem with significant environmental, social and economical consequences. The use of plant-microbe based systems for the phytoremediation of degraded soils and sediments has been increasing. Arbuscular mycorrhizal fungi (AMF) may contribute not only to overcome the difficulties in plant growth normally observed in degraded sediments, but also to improve their edaphic characteristics. The aim of the present work was to investigate the feasibility of phytoremediation strategies using black alder (*Alnus glutinosa*) inoculated with different native AMF and their effect on the rhizosphere pH of a highly alkaline anthropogenic sediment.

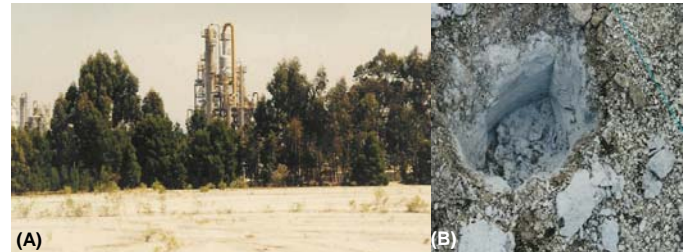


Fig. 1 General view of the anthropogenic site (A) containing highly alkaline sediments (B) in Northern Portugal.

Methods

The study site was a 10-ha anthropogenic sedimentation pond located in the industrial complex of Estarreja, Northern Portugal (Fig. 1A), into which 300 000 ton of solid waste residues from the production of acetylene and PVC had been deposited over a 26-year period. The site had scarce vegetation with a few scattered dwarfed trees, shrubs and some herbaceous plant species. The pH values of the sediment were found to be very high (between 11.8 and 12.6). Extreme alkalinity, high salinity and low nutrient levels appeared to be the main stresses for plants.

Pre-germinated seedlings of *A. glutinosa* were grown in 200 ml pots containing the alkaline sediment (Fig. 1B) and inoculated with native AMF. The experiment comprised 6 treatments: (i) non-inoculated controls, (ii) plants inoculated with *Glomus intradices* BEG163, (iii) *G. mosseae* BEG198, (iv) *G. geosporum* BEG199, (v) *G. claroideum* BEG210 and (vi) plants inoculated with a mixture of the four AMF. The plants were grown for six months under controlled greenhouse conditions. The plant biomass was determined after drying the plant material. Oven-dried leaves were finely ground, digested and their phosphorus (P) concentration determined. Fresh root samples were stained with trypan blue and the percentage of root length colonised by AMF evaluated. The length of the extraradical mycelium (ERM) was determined and expressed in cm of hyphae per 1 g of air-dried sediment. The pH of the rhizosphere was measured in water.

Results

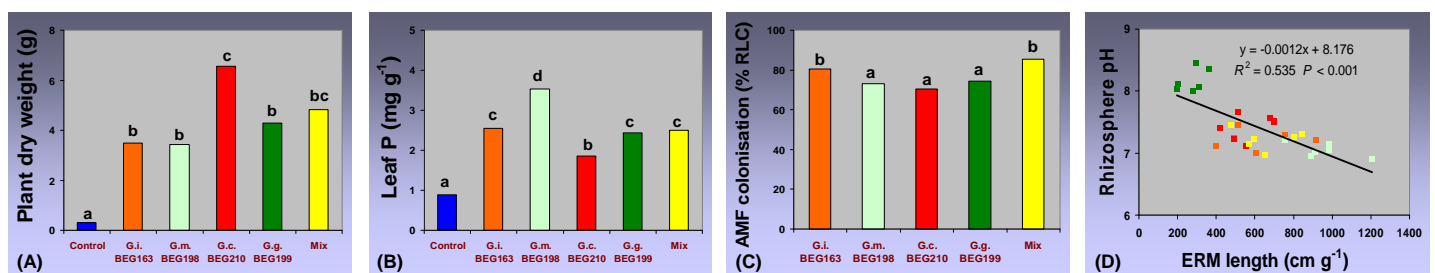


Fig. 2 Plant dry weight (A), leaf P concentration (B), AMF colonisation (percentage root length colonised) (C) and relationship between the rhizosphere pH and the ERM length (D). The values are means of 6 replicates. Columns marked with different letters are significantly different according to Duncan's Multiple Range test at the level of $P < 0.05$ (Control ■, G.i. *Glomus intradices* BEG163 ■, G.m. *Glomus mosseae* BEG198 ■, G.c. *Glomus claroideum* BEG210 ■, G.g. *Glomus geosporum* BEG199 ■, Mixture of the four AMF ■).

- Inoculated plants had significantly greater dry weight and leaf P concentration than non-inoculated controls
- Plants inoculated with *G. intradices* BEG163 or with the mixture of the four AMF had a significantly greater root colonisation
- There was a significant negative correlation between the rhizosphere pH and the ERM length
- The rhizosphere pH of plants inoculated with the AMF which produced a more extensive ERM was decreased to values closer to neutrality

Conclusions

- Inoculation with native arbuscular mycorrhizal fungi resulted in improved plant growth and nutrition
- The extraradical mycelium of arbuscular mycorrhizal fungi contributed to the amelioration of the high pH of the alkaline sediment
- Arbuscular mycorrhizal fungi can be important biotechnological tools for the phytoremediation of alkaline anthropogenic sediments

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