

ALNUS GLUTINOSA INOCULATED WITH ARBUSCULAR MYCORRHIZAL FUNGI AS A PHYTORESTORATION STRATEGY FOR A HIGHLY ALKALINE ANTHROPOGENIC SEDIMENT



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INTRODUCTION

Soil degradation constitutes a major worldwide problem with significant environmental, social and economical consequences. Phyto restoration is a technique in which selected plant species are sown or planted in the target sites, but commonly high mortality, very slow plant growth, or even no growth at all, occur due to the environmental stresses of anthropogenic soils. Mycorrhizal fungi and other beneficial soil biota may contribute to overcome these difficulties. *Alnus glutinosa* is known not only to form arbuscular mycorrhizal (AM) and ectomycorrhizal (ECM) associations, but also actinorhizal associations with N-fixing *Frankia*. The aim of the present work was to investigate the potential of inoculation of *A. glutinosa* with mycorrhizal fungi and *Frankia* in phyto restoration of highly alkaline anthropogenic sediments under field conditions.

MATERIALS AND METHODS

Study site

The study site was a 10-ha anthropogenic sedimentation pond located in the industrial complex of Estarreja, Northern Portugal (Fig. 1), 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.



Fig. 1 Field trial at the study site.



Fig. 2 Field trial after 28 months.

Experimental design

A field experiment was conducted on the site by setting up 50 plots with 1 m² (1 x 1 m) in a total area of 360 m² (17 x 18 m) (Fig. 1). Two hundred 1-year old bare root seedlings of *Alnus glutinosa* (L.) Gaertn. were purchased in a local tree nursery (Porto, Portugal). Four seedlings were transplanted onto each plot. Half of the plants were inoculated with a commercial mixture (PlantWorks, Rootgrow Professional, UK) of AM and ECM fungi and a suspension of *Frankia* spp., and the other half was left uninoculated. The mycorrhizal inoculum consisted of six AM fungal species (*Glomus mosseae*, *Glomus microaggregatum*, *Glomus intraradices*, *Glomus geosporum*, *Glomus caledonium* and *Glomus claroideum*) and five ECM fungal species (*Pisolithus tinctorius*, *Hebeloma crustuliniforme*, *Laccaria laccata*, *Lactarius piperatus* and *Paxillus involutus*). All mycorrhizal fungi were isolated from degraded ecosystems in Central Europe or Portugal and were non-native to the study site. After a period of 28 months (Fig. 2), plant mortality was measured and plant development parameters were analysed. Roots were sampled and analysed for the presence of the inoculated root symbionts.

RESULTS

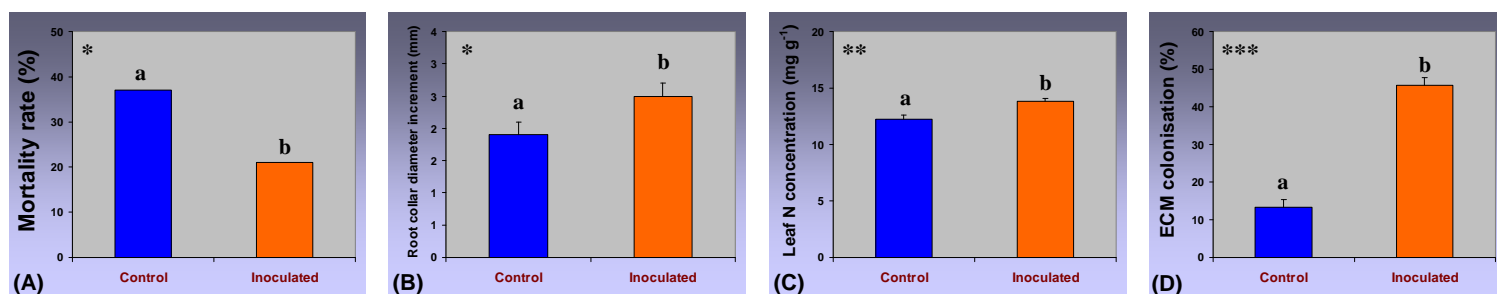


Fig. 3 (A) Mortality rate of *Alnus glutinosa* [columns marked with different letters are significantly different according to Pearson Chi-Square test ($\chi^2 = 6.22$, $df = 1$)]; (B) root collar diameter increment; (C) leaf N concentration; (D) percentage of ectomycorrhizal colonisation. Values are means \pm 1 SE. Columns marked with different letters are significantly different according to Student's *t*-test; *, **, *** significant effect at the level of $P < 0.05$, $P < 0.01$, $P < 0.001$, respectively.

- ✓ Inoculated plants showed less mortality, greater root collar diameter, leaf biomass, leaf N and Ca concentrations and ECM colonisation
- ✓ There was no significant effect of inoculation on shoot height and leaf P and K concentrations
- ✓ Neither AM colonisation nor the presence of *Frankia* nodules were observed

CONCLUSIONS

- ✓ Ectomycorrhizal fungi may play a role on the survival, growth and mineral nutrition of *Alnus glutinosa* under field conditions in extremely alkaline anthropogenic sediments
- ✓ Ectomycorrhizal fungi can be important biotechnological tools for the phyto restoration of such anthropogenic sediments

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