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To cite this version:

Lydie Le Forestier, Nour Hattab, S. Bourgerie, D. Morabito, F. Miard, et al.. GENTLE REMEDIATION OPTIONS OF COPPER CONTAMINATED SOILS: AIDED PHYTOSTABILISATION AND PHYTOEXTRACTION. 18th International Conference on Heavy Metals in the Environment, Sep 2016, Gand, Belgium. insu-01381707

HAL Id: insu-01381707
https://hal-insu.archives-ouvertes.fr/insu-01381707
Submitted on 14 Oct 2016

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GENTLE REMEDIATION OPTIONS OF COPPER CONTAMINATED
SOILS: AIRED PHYTOSTABILISATION AND PHYTOEXTRACTION

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Keywords: phytoremediation; copper; mobility; amendment; willow

Introduction

Potentially toxic trace elements (PTTE) such as As, Cu, Cr and Zn can be in excess in contaminated soils
at wood preservation sites, especially when Cu-based salts, i.e. Cu sulphate and chromate copper arsenate
(CCA) have been long term used as preservatives against insects and fungi which may result in soil
phytotoxicity (Kumpiene et al., 2008). In comparison with conventional techniques, phytoremediation
technologies are less invasive and low-cost and able to restore the physical and chemical properties of
PTTE-contaminated soils and the cascade of biological processes and functions leading to remediated
ecosystem (Mench et al., 2010). Among phytoremediation options, (1) phytostabilisation, singly and in
combination with mineral and organic amendments (i.e. aided phytostabilisation) aims at decreasing both
the labile PTTE pool and providing nutrient supply and (2) phytoextraction which uses tolerant plants and
their associated microorganisms aims at extracting and translocating PTTE from the soil to the harvestable
plant parts. Salicaceae, willows and poplars, have been shown to be efficient for phytostabilisation of
PTTE (Vamerali et al., 2009): they have a high and rapid biomass production and PTTE confinement in
their roots provides them a metal(loid)s tolerance. This study aimed at investigating the efficiency of both
phytoremediation options (i) on the mobility and bioavailability of Cu in contaminated soils and (ii) the
tolerance of Salix purpurea to Cu.

Methods

The wood preservation site is located in southwest France, in the Gironde county (44° 43’N; 0°30’W).
This anthroposol is developed on an alluvial soil in terrace (Fluvisol). Copper is the main contaminant in
topsoils, with total soil concentrations between 65 and 2600 mg kg⁻¹, showing considerable spatial
variation. The “aided phytostabilisation” serie consisted of a single incorporation of compost (5% w/w) or
dolomitic limestone (0.2% w/w), or both mixed, or no amendment in the contaminated soil ([Cu]=674 mg
kg\(^{-1}\)). The “phytoextraction” serie consisted of six amended soils followed by a crop rotation with tobacco and sunflower for 4 years and characterized by an increasing total soil Cu concentration, i.e. 163, 268, 382, 518, 753 and 1170 mg kg\(^{-1}\) (Hattab-Hambli et al., 2016). Another soil, located on the same alluvial terrace at 2.3 km from the site was sampled and used as a control soil. For each treatment, potted soils in triplicates were vegetalised by one cutting of Salix purpurea, and 3 other potted soils were left without vegetation for comparison. Soil pore water (SPW) was collected after 21, 37 and 57 days by using soil moisture samplers (Rhizon™). Electrical conductivity and pH were measured as well as major cations and anions together with total dissolved Cu concentrations. At the end of the growth period (57 days), all formed organs of Salix were collected (leaves, stems and roots) and dried to measure their dry weight and Cu concentrations were measured by ICP-AES in the different organs. Additionally a sequential extraction scheme for Cu was applied for the different soils.

**Results**

In the contaminated soil, Cu is mainly located in the oxidizable fraction, i.e. associated with Fe- and Mn-(hydr)oxides, and to a lesser extent, to the fraction linked with organic matter (Le Forestier et al., 2016). In all cases, the pH increased by one unit in soil pore water, whereas the total dissolved Cu concentrations decreased over time. Salix biomass is similar in all soils and Cu concentrations varied between 750 à 1600 µg g\(^{-1}\) in roots, in comparison to 10-20 µg g\(^{-1}\) in stems and leaves. In the phytoextraction serie, the increased total soil Cu concentrations are correlated with the increase of the total dissolved Cu concentrations, but similar Cu contents were trapped in the Salix roots.

**Conclusion**

Whatever the initial studied Cu soil concentration, the growth of Salix purpurea was possible. Copper was mainly accumulated into the root system of the tested willows avoiding the contamination of their aerial organs.

**References**


