Phytoremediation of a Former Mine Site: Miscanthus X Giganteus, a Potential Tool

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Abstract

Mining activities produce a huge amount of contaminated wastes, particularly in metallic elements and metalloids. These elements, PTEs (Potentially Toxic Elements) present serious hazards for environment namely for groundwater and food chain contamination. As classical decontamination solutions are very expensive, the necessity to find alternative rehabilitation is fundamental.

The studied site is a former gold mine where mining wastes are stored in a settled basin since 1970. Native vegetation has gradually colonized the site and an anthroposol has formed. Main PTEs are arsenic (As), lead (Pb) and antimony (Sb) with concentrations reaching sometimes several percents i.e. As levels are within 1 700 and 83 000 mg/kg, Pb within 320 and 15 000 mg/kg and Sb reaches 1 100 mg/kg.

Soils developed from mining wastes have been described and characterized. Parameters such pH, CEC, organic carbon have been measured by classical methods. Thus, pH are between 3 and 5 which is acidic. CEC is low in parental material (on average 5 cmol(+) /kg) and increase in organic horizons reaching 63 cmol(+) /kg. Organic carbon level reaches very high content (till 426 g/kg). Overall, soils are shallow.

Miscanthus x giganteus is a Poaceae originated from South East Asia which is cropped for its energetic interests (biofuel) as it has a high ligno-cellulosic biomass. Its potential adaptation on this anthroposol is assessed after 3 months of crop in phytotron. Physiological parameters such as fluorescence of chlorophyll a, gas exchanges (particularly Pn, gs, Ci and Tr), chlorophyll a and b and carotenoids content are assessed to determine whether the plant is stressed by the contamination.

Thus, values of Fv/Fm (the maximum photochemical efficiency) and gas exchanges indicate an impact on physiological activity through an inhibition of its activity and physiological development. Photohemial efficiency of photosystem II (ΘPS II) is also considered.

PTEs accumulation in biomass is assessed and bioaccumulation and translocation factors are calculated. Both never exceed 0.19 indicating a very low accumulation of PTEs even if the soils are highly contaminated.

Moreover, the bioavailability (single extraction) as well as the geochemical behaviour of PTEs in soils seem to be linked to the soil mineralogy determined by XRD and SEM.

The major conclusion is [i] the capacity of adaptation of miscanthus on very high contaminated soil and [ii] its use to phytostabilize and valorise contaminated soils for energy cropping. Without any fertilization, the biomass yield is however lower than crops on a compost. Other tests with sustainable fertilization should be performed.