Phytoremediation of contaminated sites by Trichloroethylene using Zea Mays L.

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Trichloroethylene (TCE) is a chlorinated solvent that belongs to the class of DNAPLs (Dense Non Aqueous Phase Liquids) pollutants (SWILLE 1988). The physical and chemical properties of DNAPLs, especially the low solubility in water, the high density (>>1g/cm^3) and the high affinity for organic compounds, cause a deep penetration of DNAPLs in the subsurface following accidental spills or intentional damping (SWILLE 1988, MILLER & HAWTHORNE 2000).
Different chemico-physical remediation techniques were devised for the removal of DNAPLs from ground and surface waters, including: air stripping, adsorption processes, pump and treat and surfactant enhanced dissolution (KHACHIKIAN 2000, HUANG 2011). However, especially in the last few years, biological methods based on phytoremediation have been developed for the removal of organic pollutant and heavy metals from the environment (DOTY 2007, ALI & SAJAD 2013).

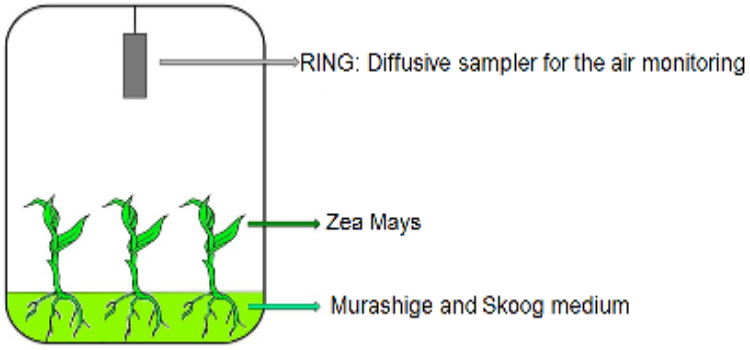

Fig.1 Scheme of the Experimental Setup

In this respect, *Zea mays* L. has been successfully employed in phytoremediation of soils and waters polluted by heavy metals (WUANA & OKIEIMEN 2010, MENCH & MARTIN 1991).
In this work we show that *Z. mays* is effective also in the removal of TCE from an artificial contaminated soil.
In particular, it was found that the plant adsorbs and metabolizes TCE with an efficiency ranging from 40 to 60 % of the total TCE present in the system.
Our experimental setup is sketched in Fig. 1 and it consists of a closed incubation chamber where plants were grown on a M&S medium and exposed to different concentrations of TCE. In order to assess the mass balance and understand the fate of TCE after 9 days of incubation, an atmospheric passive diffusive sampler (RING) was also present inside the chamber.
Analyses on different components of the system (soil, plant and atmosphere) were performed by means of GC-MS, LC-MS and GC-FID. In particular, LC-MS measurements showed the presence of TCE metabolites (dichloroacetic acid, trichloroacetic acid,ecc) (CHAPPELL 1998) in the areal part of the *Z. mays*.
These preliminary results encourage further studies for the employment of *Z. mays* for phytoremediation processes of soils contaminated by TCE and, potentially, other chlorinated DNAPLs.

Reference

Ali, H., Khan, E., Sajad, M.A., 2013. Phytoremediation of heavy metals—concepts and applications. Chemosphere 91, 869–881.
Chappell J. , 1988. Phytoremediation of TCE in groundwater using Populus. English U.S Protection Agency, Office of Solid Waste e Emergency Response, Technology Innovation Office.
Doty, S.L., James, C.A., Moore, A.L., Vajzovic, A., Singleton, G.L., Ma, C., Khan, Z., Xin, G., Kang, J.W., Park, J.Y., others, 2007. Enhanced phytoremediation of volatile environmental pollutants with transgenic trees. Proceedings of the National Academy of Sciences 104, 16816–16821.
Huang, L., Yang, Z., Li, B., Hu, J., Zhang, W., Ying, W.-C., 2011. Granular activated carbon adsorption process for removing trichloroethylene from groundwater. AIChE journal 57, 542–550.
Khachikian, C., Harmon, T.C., 2000. Nonaqueous phase liquid dissolution in porous media: Current state of knowledge and research needs. Transport in Porous Media 38, 3–28.
Mench, M., Martin, E., 1991. Mobilization of cadmium and other metals from two soils by root exudates of Zea mays L., Nicotiana tabacum L. and Nicotiana rustica L. Plant and soil 132, 187–196.
Miller, D.J., Hawthorne, S.B., 2000. Solubility of liquid organics of environmental interest in subcritical (hot/liquid) water from 298 K to 473 K. Journal of Chemical & Engineering Data 45, 78–81.
Schwille, F., Bertsch, W., Linke, R., Reif, W., Zauter, S., 1988. Dense chlorinated solvents in porous and fractured media; model experiments. Lewis Publishers.
Wuana, R.A., Okieimen, F.E., 2010. Phytoremediation potential of maize (Zea Mays L.): A review. African Journal of General Agriculture 6, 275–287.