1.5 = Contaminant assessment and bioremediation of urban soils: a case study

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Urban agriculture has grown rapidly in the last years, thanks to the possibility of producing fresh foodstuffs at low cost and to reduce socio-economic and environmental issues. However, urban gardens are exposed to continuous pollution caused by emission from road traffic, domestic heating, previous industrial use of the sites, atmospheric deposition from industrial activities, with the main pollutants being represented by heavy metals and organic compounds, i.e polycyclic aromatic hydrocarbons (PAH). Plants may absorb and accumulate toxic elements, depending on species and environmental conditions. Hence, the evaluation of the content and bioavailability of the heavy metals in the soil, of the presence of PAHs and of the pollutants uptake and accumulation capacity of plants are fundamental to estimate the risks resulting from the consumption of plants and to properly manage the areas. Several technologies for remediation of contaminated soils have been developed. Bioremediation, in particular phytoextraction for metals and biodegradation for organic pollutants, is a passive, low cost, in situ approach, which uses plants and/or soil microorganisms, bacteria and fungi, to reduce concentration of pollutants.
The results here presented have been obtained within the project “Re-Horti”- Strategies to reuse urban areas for horticulture, aimed (1) to identify an experimental site between different areas in the city of Turin, chosen to be reused as urban gardens; (2) to purify the identified area by using phytoexctraction and biodegradation through soil fungi; (3) to test the effect of an organic soil conditioner on plant and fungus growth and soil restoration. Plants for phytoremediation were chosen on the basis of the literature, sunflower (*Helianthus annuus*) and maize (*Zea mais*) for their great biomass and high rate of growth, *Brasssica juncea* for the fast reproductive cycle that allows more crops per year, the fern *Pteris vittata* for its capacity to accumulate arsenic and different metals. Biodegradation technology included: (i) the characterisation of cultivable autochthonus mycoflora from different stratigraphic layers; (ii) the isolation and selection of fungal strains with a biodegradation potential through a degradation-focused screening process; (iii) the analysis of the suitable technique for the inoculum in urban horticultural soil. The soil was characterized and metals, both in the soil and the plants, were chemically analyzed through ICP-OES, GF-AAS, ICP-MS. Among the organic pollutants the sixteen most frequent and/or dangerous PAHs selected by US-EPA were studied using HPLC-UV/VIS and GC-MS techniques.
Results showed that the soil chosen for the experiments was strongly polluted by heavy metals (in particular by lead and, to a lesser extent, by Zn, Cr, Ni, As) and by organic pollutants, especially pyrene, perylene and anthracene.
Preliminary results on phytoextraction showed the highest leaf concentrations of lead in *B. juncea* and, in the same species, the highest translocation factor (TF) from roots to shoots for all metals. The only exception was represented by the TF for the As in *P. vittata*. The addition of the soil improver had a contrasting effect on leaf accumulation, depending on both plant species and metal.
Since the choice of the correct consortium to be applied in a fungal bioaugmentation process is a critical step, particular effort was given to the isolation and the characterization of the expressed metabolic pathway of the isolated fungi. Strains belonging to 29 species were isolated. Among them, 19 strains were capable of use as sole carbon source at least one pollutant (pyrene, phenanthrene, paraffin oil) more than the glucose, showing impressive adaptation skills. The tested strains showed a peculiar growth behaviour; the growth skills on each pollutant were strain-dependent. *Thermoascus crustaceus* and *Trichoderma asperellum* were the only ones capable of growing both on pyrene and phenanthrene with a growth comparable to the control. Very good growth skills were observed for *Fusarium proliferatum, F. oxysporum, Aspergillus terreus* and *Coniochaeta canina* in the presence of alkanes. The choice of the microbial consortium to be applied was not limited only to the degradation capabilities, but it was designed accordingly also to the production of biosurfactants and the capability to grow on ligninocellulose substrates that were used as carriers to vehiculate the microorganisms into the soil. The best microbial consortium has been inoculated *on site* and trials are in due course.