Research Advances in Phytoremediation Technology in China

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Phytoremediation technologies, including phytoextraction and phytostabilisation for toxic metal pollutants and phytodegradation for persistent organic pollutants, have been increasingly considered as an emerging green environmental biotechnology in China. This presentation summaries present research advances in the phytoremediation in the country, covering (1) the native hyperaccumulator plants for phytoextraction of As, Cu, Zn, Cd, Pb, and Mn; (2) chelator/mixed agents-enhanced metal phytoextraction and environmental risk assessments; (3) phytoremediation application to metal polluted sites; (4) plant-assisted microbial remediation of persistent organic pollutants (POPs); (5) future prospects of phytoremediation technologies in China.

(1) The native hyperaccumulator plants for metal phytoextraction

In the past five years much effort was made for exploration of valuable hyperaccumulator and accumulator plants. Several native hyperaccumulators were found and reported in China, including Chinese brake fern (Pteris vitatta) and Pteris cretica for As, Sedum alfredii H for Zn/Cd/Pb, Phytolacca acinosa Roxb for Mn etc. Further evidence may be required for supporting some of the reported other plants as hyperaccumlators.

(2) Chelator-enhanced metal phytoremediation and environmental risk assessments

Chelator enhanced phytoextraction was proposed to overcome limitations due to low metal solubility, bioavailability and low metal translocation from shoot to root. A variety of chelators have been tested for their effectiveness on enhanced phytoextraction of soil metals. Chelators (for example, EDTA and EDDS etc.) have been shown to significantly increase metal concentrations in soil solution. However, the enhancement on plant uptake varies greatly, depending on specific metal, chelate, plant combination and soil conditions. Uncustomized addition of chelates will result in unsuccessful phytoextraction meanwhile cause negative effects on eco-environment.

(3) Phytoremediation application to metal polluted sites

Intensive researches have been continuously conducted for explanation of metal tolerance, hyperaccumulation and detoxification in the plants and also for exploitation of the bioresources. Three phytoextraction-based site remediation demonstrations for As, Cu and Zn have been under construction experimentally in China. The recycling technologies of the harvested plants as a resource have been studied.

(4) Plant-assisted bioremediation (Rhizo-remediation) of POPs

Polycyclic aromatic hydrocarbons (PAHs) are persistent organic pollutants in soils. Bioremediation of PAHs contaminated soils has been experimentally studied using microorganisms and plants in laboratory and grasshouse scales. Plant-assisted bioremediation of phenanthrene or Benzo- α -pyrene (B[a]P) contaminated soils was investigated using plants such as ryegrass, clover and alfalfa. Ryegrass could not only improve the degradation of B[a]P in soil, but also accumulate small amount of B[a]P in their tissues. Clover could increase the decomposition of B[a]P in the soils co-contaminated with B[a]P and copper. Phytodegradation of B[a]P contaminated soil could be promoted by mycorrhizal alfalfa *(Medicago sativa)* colonized by *Glomus caledonium.* Rhizo-remediation of POPs polluted soil needs further explanation and exploitation.

(5) Research prospects of phytoremediation technologies in China

In general, research and development of phytoremediation are just beginning in China. The advances in phytoremediation research are remarkable theoretically and practically. Using natural green resources to tackle natural environmental pollution will be an encouraging issue in China. Research target for phytoremediation of soils contaminated with heavy metals will continuously focus on (1) screening and breeding of metal hyperaccumulating plants; (2) development and optimization of phytoremediation and plant-microbe combined remediation of heavy metal contaminated soils; (3) integrated phytotechnology application and management systems in contaminated sites. Further research is also needed to screen environment-friendly and cost-effective chelate/mixed agents and optimize processes involved in chelate induced phytoextraction to site specific conditions. Applied phytoremediation/bioremediation of soils contaminated with pesticides, petroleum and POPs will be developed in the future. Other relevant work is also important for research and application of phytotechnology, including promotion of public awareness, guidelines and legislation enforcement, environmental monitoring and assessment, management of phytoremediation sites, marketing stragety, and cooperation between regions such as forum, network and funding mechanisms.