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Editorial Open Access

The Importance of Phytoremediation of Heavy Metal Contaminated Soil Using Vermicompost for Sustainable Agriculture

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Editorial

Heavy metal contamination of soils and food supply is not just a modern phenomenon. It has occurred ever since humans mined and smelted metals. Soil pollution in the Bronze Age is evidenced by the heavy metal concentrations in ancient skeletons [1]. Legacy contamination from pre-industrialization metalliferous periods of human history is still found in soils and bogs [2]. Since the beginning of the industrial pollution, contamination of the biosphere with toxic trace metals has further increased and become a world-wide public health concern [3,4]. Heavy metal pollution has been "globalized" by large scale use, and atmospheric transport mechanisms [4]. Contamination by heavy metals is a critical contributor to soil and water quality degradation, as well as to human and animal health because they bioaccumulate in the food chain [5,6]. Major sources of heavy metal contaminations in China were identified as manufacturing, solid waste, and waste water [7]. Chronic accumulation of these heavy metals jeopardizes soil ecosystems services by decreasing the soil quality for crop growth, as well as disturbing the activities of soil organisms [8,9].

Classical heavy metal remediation comprises the removal of the contaminated soil [10] followed by disposal on landfills or immobilization treatment of the contaminated soil [11]. This is costly. Phytoremediation, on the other hand, is a cheaper technique [12] that combines several methods to remediate soil contaminated with heavy metals, and other toxic pollutants [11,13]. Phytoremediation includes plants selected for their ability to accumulate metals (e.g. phytochelating plants that can remobilize metals with the goal of plant uptake), soil amendments and agronomic practices that support the growth of plants.

Addition of organic matter amendments may immobilize heavy metals (e.g., Cd, Pb, As, Ni, Co) for soil amelioration, [11] but it may also increase growth rates of plants used in phytoremediation, and as a result, increase pollutant removal efficiency [14,15]. Vermicompost is produced through the degradation of organic wastes through the action of earthworms that results in the bio-oxidation and stabilization of wastes. The manufacturing process of vermicompost differs from traditional composting which requires a thermophilic stage, while vermicompost undergoes a mesophilic transformation [16]. The resulting vermicompost material is a fine-textured, peat-like material which has structural properties that help in retaining water and facilitating aeration [16]. In addition, it increases cation exchange capacity (CEC) in soils, promoting adsorption of positive ions, including heavy metals [17,18]. While adsorption to CEC sites seems counterproductive, cation exchange can re-release these metals for uptake by metal accumulating plants.

Vermicompost is known to enhance plant growth, and thus help with phytoremediation while at the same time temporarily immobilize metal pollutants. Incidentally, earthworms themselves are bioaccumulators [19] and thus can be used to bioremediate metal contents of compost produced from urban wastes. We are currently conducting experiments to test the combined efficacy of phytoremediation and vermicompost in mitigating urban storm runoff quality in bioretention basins, a type of green stormwater infrastructure which has the potential to improve runoff quality, and reduce quantity before the runoff is released into receiving water bodies. Our pot-scale experiment utilizes various organic matter amendments (vermicompost, coconut fiber, and regular compost) to support the growth of switch grass in a typical, sandy road-side soil types. The data will help in the design of urban best management practices for storm water management.

Beyond this specific project, phytoremediation needs to be seen as a tool in sustainable agriculture too. While phytoremediation is becoming an important tool in bioremediation of metal contamination in soils, it is essential to continue research in this area to identify hyper accumulators. These plants are highly adapted to accumulate toxic trace metals while growing rapidly in contaminated soils [20]. Their use in all forms of agriculture, from urban to rural, may prevent the loss of important agricultural soil resources through metal contamination.

Economic development and an ever rising world population is putting enormous stress on food systems. To feed nearly 9 billion people by 2050, a new vision is needed that ensures food supply, environmental sustainability and economic opportunity through agriculture. Agriculture sustainability is vitally important to support the expanding popultation, and one that does not compromise soil health. In sustainable agriculture more of the nutrients in food waste and sewage need to be returned to the soil. Field application of sewage and composts dervied from urban wastes may actually cause metal contamination. It is thus even more important that efficient phytoremediation techniques are at the ready to keep soils fertile. This may start with the waste processing where phytoremediation, and indeed vermiculture can help produce better, sustainable fertility amendments to avoid nutrient deficiencies, as are seen in some parts of Turkey [21].

Agriculture is a one of the main areas of development in devoloping countries like Turkey. The increasing interest in the use of vermicomposts as plant growth media, and soil amendment should extend to its use in phytoremediation. Apart from environmental clean-up, other co-benefits that may arise through this practice ranges from raising soil organic matter to reduced soil erosion, and improved biodiversity by encouraging the development of healthy soil ecosystems, all of which will ultimately improve soil quality and productivity within sustainable agriculture.

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