From Forest Nursery Notes, Winter 2010

141. © Migration of heavy metals in soil as influenced by compost amendments. Farrell, M., Perkins, W. T., Hobbs, P. J., Griffith, G. W., and Jones, D. L. Environmental Pollution 158:55-64. 2010.

Environmental Pollution 158 (2010) 55–64

Contents lists available at ScienceDirect

Environmental Pollution

journal homepage: www.elsevier.com/locate/envpol

Migration of heavy metals in soil as influenced by compost amendments

Mark Farrell[a,*], William T. Perkins[b], Phil J. Hobbs[c], Gareth W. Griffith[d], Davey L. Jones[a]

[a] School of the Environment and Natural Resources, Bangor University, Gwynedd LL57 2UW, UK
[b] Institute of Geography and Earth Sciences, Aberystwyth University, Ceredigion SY23 3DB, UK
[c] North Wyke Research, Okehampton, Devon EX20 2SB, UK
[d] Institute of Biological Environmental and Rural Sciences, Aberystwyth University, Ceredigion SY23 3DA, UK

Composts increase rooting depth and vegetation growth over inorganic amendment in an acidic, contaminated soil.

A R T I C L E I N F O

Article history:
Received 16 April 2009
Received in revised form
31 July 2009
Accepted 4 August 2009

Keywords:
Acidity
Municipal solid waste
In situ immobilization
Land restoration
Organic matter
Soil pollution

A B S T R A C T

Soils contaminated with heavy metals can pose a major risk to freshwaters and food chains. In this study, the success of organic and inorganic intervention strategies to alleviate toxicity in a highly acidic soil heavily contaminated with As, Cu, Pb, and Zn was evaluated over 112 d in a mesocosm trial. Amelioration of metal toxicity was assessed by measuring changes in soil solution chemistry, metal leaching, plant growth, and foliar metal accumulation. Either green waste- or MSW-derived composts increased plant yield and rooting depth, reduced plant metal uptake, and raised the pH and nutrient status of the soil. We conclude that composts are well suited for promoting the re-vegetation of contaminated sites; however, care must be taken to ensure that very short-term leaching pulses of heavy metals induced by compost amendment are not of sufficient magnitude to cause contamination of the wider environment.

1. Introduction

Alternative long-term sustainable strategies to the disposal of municipal solid waste (MSW) in landfill are being sought in most industrialised nations worldwide. It is imperative, however, that these strategies have low environmental, social and economic effects. Methane emitted from landfill sites is the largest source of greenhouse gas (GHG) produced by the waste management sector, and treatments such as composting have been employed to mitigate against this action (IPCC, 2007). European Union (EU) Council Directive 1999/31/EC (EC, 1999) on the landfill of waste has set down strict mandatory targets to reduce the amount of Biodegradable Municipal Waste (BMW) entering landfills. This EU Directive also states that no waste may be deposited in landfills without first being treated to reduce its subsequent environmental impact. Mechanical Biological Treatment (MBT) can be used to pretreat residual mixed wastes after recyclates have been removed ultimately to produce a quasi-stabilised, compost-like substance (Binner and Zach, 1999). Whereas according to EC (1999), this treated material is suitable for landfill, it is desirable to find alternative uses for this mixed waste compost. This position is supported by Bockreis and Steinberg (2005) who demonstrated that MBT-treated wastes still have a large potential to produce methane in an anaerobic landfill environment. As soil organic matter levels have declined to critical levels in many regions of the world, compromising their ability to deliver ecosystem services (Bellamy et al., 2005), it is advantageous to recycle this 'waste' organic matter to land. However, this land spreading must occur without unduly increasing the loading of inorganic and organic contaminants onto previously uncontaminated soils. One proposed use for mixed waste composts is in the remediation of heavy-metal contaminated sites, where the addition of heavy metals may not pose such a problem, provided they are added in non-labile forms.

Soil-borne heavy metals must be either removed or stabilised into a less environmentally available form for successful remediation (Kiikkilä et al., 2001). The former is generally carried out "*ex situ*", causes soil structure deterioration and comes at high economic cost, limiting its use on vast contaminated areas. Biostabilisation techniques tend to be carried out "*in situ*" and are less expensive, more time consuming, and prone to uncertainty. Soils can reduce mobility and bioavailability of heavy metals naturally, as they are retained in soil by sorption, precipitation, and complexation reactions (Kabata-Pendias, 2000; Pérez-de-Mora et al., 2005). This natural attenuation process (natural remediation) can be accelerated by the addition of organic amendments (Bolan et al., 2003). Brown et al. (2003) concluded in their study that biosolids

* Corresponding author at: School of the Environment, Natural Resources and Geography, Environment Centre Wales, College of Natural Sciences, Deiniol Road, Bangor University, Gwynedd LL57 2UW, UK. Tel.: +44 1248 38 3062; fax: +44 1248 370731.
E-mail address: m.farrell@bangor.ac.uk (M. Farrell).

0269-7491/$ – see front matter © 2009 Elsevier Ltd. All rights reserved.
doi:10.1016/j.envpol.2009.08.027