Composting for Soil Improvement in the United Kingdom

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Abstract: The United Kingdom (UK) is required, as a member of the European Union (EU), to divert approximately 20 million tonnes per annum of organic municipal "wastes" from disposal to landfill by 2020. Most of the reduction will be achieved by composting. Compost is a valuable source of organic matter, nutrients and beneficial microorganisms. The use of "green compost" to convert low-quality mineral material into a manufactured topsoil, meeting the British Standard for topsoils (BS 3882:1994), is illustrated by two examples. In both examples, the compost had been acidified using a process developed and patented by the authors. In Example 1, an alkaline sandy subsoil was converted in situ into a fertile topsoil and, despite adverse conditions, young trees were successfully established as part of a major landscaping project. In Example 2, highly alkaline demolition fines were converted into a manufactured topsoil whose properties met BS 3882:1994 General Purpose grade. In both examples, long-lasting improvements were achieved in pH, organic matter content and nutrient levels. It is concluded that there is considerable potential for composts as soil improvers.
Keywords: landfill, compost, acidification, topsoil, soil-improvement

1 Introduction

The United Kingdom (UK) is required, as a member of the European Union (EU), to reduce disposal of organic municipal "wastes" to landfill and damage to the environment caused by burial of organic matter:

- emissions of methane (a key "greenhouse gas")
- pollution of water
- other damage

By 2020, 65% of approximately 32 million tonnes per annum of such material will need to be diverted from landfill in order to meet the European Landfill Directive (at least 300 kg per inhabitant). This target does not include non-domestic wastes: sewage, forestry, agriculture, food processing, catering and other industries (eg paper processing and furniture) [9].

Based on experience in other countries [8] and opinion within the UK itself, composting seems likely to provide most of the reduction because:

- capital cost can be significantly lower than incineration and anaerobic digestion
- incineration is commonly perceived to be less environmentally benign
- compost has several potential uses [1][6][12][13], notably
  – soil improvement
  – topsoil manufacture
  – top dressing
  – tree establishment
  – growing media

The usefulness of compost is based on its content of organic matter and nutrients (largely slow-release), plus its liming value and its capacity to suppress root disease [5][8][9].

Compost is claimed to benefit a wide range of soil types. However, light sandy soils stand to benefit most in terms of enhanced:

- cation exchange capacity (CEC)
- water-holding capacity
- adhesion of mineral particles

- microflora
- nutrient levels

The use of compost to convert infertile, soil-like, mineral materials into productive "topsoils" that meet the British Standard 3882:1994 for Topsoil has been investigated. Two examples are described:

Conversion in-situ of an alkaline sandy subsoil

Conversion of highly alkaline demolition fines (DF)

2 Methodology

Most composts are slightly alkaline: an advantage in most applications to land. [6] However, in both of these cases, an acidic compost was required. A cost-effective acidification process was developed by Rainbow Wilson Associates and patented in the UK. The "Compaid Process" reduces compost pH immediately and, although the buffering capacity causes pH to recover somewhat, pH can be stabilised at significantly below the initial value. [11]

In both cases, "green compost" (alias composted green waste or composted yard waste: botanic residues from householders and landscapers) was produced in outdoor windrows and screened to <8 mm. [4]

Example 1

Conversion in situ of an alkaline sandy subsoil (at Sizewell Power Station, UK)

More than 20,000 m^3 of subsoil had been excavated during construction of Sizewell B power station. The "soil" - mostly sand and seashells - was built up into an L-shaped mound up to 8 metres high, bordering the shore. Analysis of the "soil" confirmed that levels of organic matter, N, P, K and Mg were all very low and pH was very high (see Table 1, before application).

Table 1 Analysis of "Topsoil"*

		Before application	1 year after application	General Purpose Topsoil	Economy Topsoil
Organic matter	% m/m**	0.1	2.3	5 – 50	NA
Ph		8.8	7.8	5.0 – 8.2	5.0 – 8.2
Total Nitrogen as N	g/kg dry matter	0.075	1.7	≥ 2.0	NA
Phosphorus as P	mg/l as received	17	190	≥ 16	NA
Potassium as K	mg/l as received	50	179	≥ 121	NA
Magnesium as Mg	mg/l as received	35	134	≥ 26	NA
Stones (>2mm)	% m/m	ND	ND	< 60	< 65

* by British standard methods (BS3882:1994)(3); sampled by auger to 150 mm

** as loss @ 450°C on dry matter basis

NA = not applicable

ND = not determined

Green compost was treated with the Compaid Process, reducing pH from 8.8 to 6.5 at a cost of US $2/m^3 compost. As expected, reduction in pH increased the solubility-in-water of cations and phosphorus and thus increased Electrical Conductivity (see Table 2).

In August 1997, 4,000 m^3 of Compaid-treated green compost (CGC) were applied to a depth of 50 mm, followed by rotavation to a depth of 150 mm). The contractors remarked how rapidly the CGC took effect: just hours after application, the soil surface felt more stable.

Two months later, the bank was sown with *Lotus corniculatus*, *Ulex europaeus* and a mixture of native grasses. In addition, 50,000 cell-grown native trees (400 mm — 600 mm tall) were planted at a density of 2,250/ha. Despite absence of irrigation on a dry, exposed site, tree mortality in the first year was remarkably low: 1% for areas outside the mound and less than 10% on the mound.

One year after application, analysis of the topsoil showed a marked improvement in key properties - the term "topsoil" was at last merited (see Table 1, 1 year after application).

Table 2 Analysis of the CGC. (wherever properties are altered by the Compaid Process, typical and comparable values for untreated Green Compost are given in parenthesis)

pH*	6.5 (8.8)				
Moisture content*	30% m/m	142 g/litre			
Bulk density*	475 g/litre				
Electrical conductivity*	750 μS/cm^{-1} (600)				
Organic matter*(as loss @ 550°C on dry matter basis)	40% m/m	133 g/litre			
Total nitrogen as N (by Kjeldahl)	2750 mg/litre as received				
NH_4-N as N	Nil				
NO_3-N as N	75 mg/litre				
mg/l	Total		Water-soluble		
Phosphorus as P	1200	(700)	400	(20)	
Potassium as K	1500		800	(700)	
Magnesium as Mg	550		30	(15)	
Iron as Fe	3000		75	(15)	
Sulphur as S	500		80		
Particle size distribution ("sieve analysis")	% m/m passing				
4.0 mm	100				
2.0 mm	90				
1.0 mm	70				
0.5 mm	50				
0.25 mm	25				

*determined using methods in British Standard 4156: 1990[(2)] or derivatives thereof (as used for peat and other organic-based substrates).

Fig. 1 Application of CGC

Fig. 2 12 months after application (note untreated brown area indicated in front of the power station)

Fig. 3 Before application

Fig. 4 12 months after application

Example 2

Conversion of highly alkaline demolition fines (DF)

In the UK, several million tonnes of fine, soil-like mineral matter are separated from demolition waste (timber, concrete, bricks etc) per annum [7]. The DF are usually heavily contaminated with mortar and are, therefore, highly alkaline. Despite a severe shortage of topsoil within the UK landscaping industry, this material is usually landfilled because it is:

- very alkaline
- lacking in organic matter
- usually low in nitrogen
- sometimes contains physical contaminants (glass, metal etc)

and would, therefore, not meet the British Standard for Topsoil (BS3882:1994), even for "economy" grade.

Application of the Compaid Process to a 1:2 by volume mixture of green compost (GC) and demolition fines, reduced pH from >9 to <8.0 and increased both organic matter content and total N content such that the "manufactured topsoil" met BS3882:1994, General Purpose (see Table 3). Cost of the Compaid Process in such an application is at least US$3/tonne in the UK, depending on alkalinity of the DF.

Table 3 Conversion of demolition fines into "topsoil"using Compaid-treated green compost (CGC)

		Demolition fines (DF)	General Purpose Topsoil	Econom y Topsoil	CGC	DF + CGC**
pH		9.4 — 9.9	5.0—8.2	5.0—8.2	6.0	< 8.0
EC in Ca_2SO_4 solution	μS/cm*	2400	NA	NA	800	2,000
OM (LOI)	%DM	3.3-3.8	5-50	NA	25	10
Total N	%DM	≤ 0.10	≥ 0.2	NA	1.0	0.3
Extractable P	mg/l	41	≥ 16	NA	250	> 110
K	mg/l	740	≥ 121	NA	1000	830
Mg	mg/l	43	≥ 26	NA	30	39
Stones (>2mm)	% m/m	13	< 60	< 65	Insignificant	9

Free from weeds, fragments of glass, bricks, concrete etc

* If > 2,800 μS/cm, % exchangeable sodium should be determined

** 67% v/v DF + 33% v/v GC

NA = not available

3 Conclusions

Green compost has the potential to:

- enhance low grade soils in situ in terms of organic matter and nutrient content
- reduce landfilling of demolition fines
- increase supply of "topsoil" manufactured to meet BS3882:1994
- reduce reliance on soil stripping for use in landscaping and growing media
- where soils or DF are alkaline, pH can be reduced to an acceptable value using the Compaid Process
- However, both substrates must be essentially free of contaminants: as in all manufacturing processes "garbage in, garbage out"

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