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SEWAGE SLUDGE AS A FERTILIZER IN AMENITY AND RECLAMATION PLANTINGS
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Summary

The potential for using sewage sludge as a fertilizer in amenity and reclamation plantings is outlined. It is concluded that on nutrient-poor sites, sludge may be a useful source of nitrogen and phosphorus. Sludge can be applied relatively easily to woodland sites, and there is little risk of pollution, toxicity or pathological problems provided that it is not severely contaminated with industrial effluent.

Introduction

1. At present, most sewage sludge is used in agriculture, accounting for 43% of the total annual production of 1.1 million tonnes (dry solids basis) (Department of the Environment, 1993). About 30% is disposed of at sea, but this outlet has become environmentally unacceptable (House of Commons, 1987) and will cease at the end of 1998. Other methods of sludge treatment and disposal are being sought by the water industry to provide secure, environmentally safe outlets. Sewage sludge has much to offer as a fertilizer and soil conditioner, it contains large amounts of nitrogen and phosphorus, and its organic content can improve soil structure.

Types of sewage sludge

2. In general, sewage sludge may be liquid or dewatered, digested or undigested. The type of treatment is largely influenced by economic, historical and environmental factors. The more treatment sludge receives, the more innocuous it becomes – for instance, digested sludge has no offensive smell. Most water companies digest sludge where this is economic though some sewage works are too small to justify installing a digester. These produce undigested, raw sludge which may contain some gross debris.

Properties of sewage sludge

3. Table 1 gives typical values of some properties of the four main sludge types. All sludges contain nitrogen (in various proportions of ammonium nitrogen and organic N), phosphorus and organic matter. Some contain lime at up to 20% of the sludge dry solids which has been added as part of the treatment process. Only small quantities of potassium and some trace elements are present. The organic components of sludge are especially important to tree growth, as they act as slow-release nitrogen fertilizers.

4. Sludge also contains some elements potentially toxic to trees; some results from industrial discharges to the sewer; but trade effluent control measures introduced in recent years have been effective in eliminating point source inputs of contaminants. In contrast, the many sources of domestic sewage, which contains zinc from cosmetics and copper from water pipes etc, limit sewage usage. Nevertheless, although these elements occur in sludge at higher concentrations than

in normal soils, the application of sludge in amounts suitable for trees, even when repeated during the life of a crop, will usually result in a negligible increase in their level in the soil.

Sludge type	Total		Available[a]		% dry solid
	N	P	N	P	
Liquid undigested (kg/m³)	1.8	0.6	0.6	0.3	5
Liquid digested (kg/m³)	2.0	0.7	1.2	0.3	4
Undigested cake(kg/t)[b]	7.5	2.8	1.5	1.4	25
Digested cake(kg/t)[b]	7.5	3.9	1.1	1.9	25

Notes [a] Available in the first growing season
[b] Wet tonnes

Types of site suitable for sewage sludge applications

5. Trees are often planted on land low in nutrients, either because it is intrinsically poor, or has been reclaimed following mineral extraction or dereliction. On many reclaimed sites, topsoil is absent, or if imported it has poor chemical and physical properties. Tree response to applications of sewage sludge is likely on any site which suffers from nitrogen or phosphorus deficiency provided other site factors such as drainage or soil bulk density are satisfactory. Natural soils which commonly have these nutrient deficiencies include podzols, ironpan soils, unflushed peats, calcareous, littoral and skeletal soils. Colliery, open-cast coal and china clay spoils are examples of man-made sites likely to benefit from sludge applications. However, application of sewage sludge on waterlogged soils or spoils may lead to anaerobic conditions, and consequent harm to trees.

6. Research in Britain (Bayes *et al*., 1991) has shown sewage sludge can benefit some conifers (Corsican pine, Scots pine, Sitka spruce and Japanese larch) planted on nutrient-deficient sites. Other work suggests most conifers are likely to benefit. At present, there has been less research on broadleaved species. Though these, too, are likely to benefit from sludge if nutrient availability is limiting growth.

Application methods and rates

7. Sewage sludge can be applied at three stages in woodland's life (a) before planting or after clearfell, (b) when trees are 1-5 years old and small enough to straddle with spraying equipment and (c) when stands have been thinned and extraction racks have been cut, allowing tankers or other equipment into the stand.

8. Before planting, a site can be sprayed with liquid sludge using a conventional slurry tanker drawn by a tractor, or by an irrigation raingun fed by piping from a stationery tanker or lagoon. An application rate of 200m³ ha^{-1} is recommended, and will supply about 130kg ha^{-1} total phosphorus, and about 400kg ha^{-1} total nitrogen. Alternatively, cake sludge can be applied, either by agricultural muck spreader, or by a bulldozer. A rate of 50 wet tonnes ha^{-1} will supply 140-195 kg ha^{-1} total phosphorus and about 375kg ha^{-1} total nitrogen. Depending on site requirements, the sludge can be turned into the soil by ploughing or ripping prior to planting.

9. Until trees are approximately 5 years old, liquid sludge can still be applied over a site by using a retractable reel irrigation system. This consists of a raingun mounted on three wheel trolley, connected to a hose reel by a length of heavy duty polythene hose. Provided the trolley has a high cross beam, negligible damage is inflicted on the trees. An application rate of 200m^3 ha^{-1} can be applied without damaging the trees. From the roadside, sludge can also be applied using purpose-built sludge tankers which allow sludge spreading either via a rear nozzle, or from a spray gun

mounted on the top of the tanker. Sludge can be discharged up to 100m from the tanker using the latter method.

10. Once trees are older that about 5 years, sludge application is difficult until the woodland reaches the age for thinning. Then extraction racks cut into the wood allow access for spraying equipment. Retractable rainguns have been successfully used in thinned woodland, but some sites will allow the use of a slurry tanker. Application rates of $200m^3\ ha^{-1}$ are suggested, though poor sites may benefit from repeated applications every five or ten years.

Advantages and disadvantages of sludge application

11. Research in Britain has shown that trees on nutrient-poor sites will usually grown better with applications of sludge than without; foliar levels of nitrogen and phosphorus are enhanced, and can be brought above deficient levels. Sludge applications at suggested rates can also be more effective than artificial fertilizers in promoting growth and foliar uptake of nutrients.

12. Application of sewage at the suggested rates will usually lead to increased weed vigour, and weed control will be necessary for newly planted trees. Before canopy closure the application of liquid sludge can be beneficial on heathland sites because heather growth is restricted in favour of grasses and other herbs. The elimination of heather is important where it would check the growth of a tree species.

13. Application of sewage sludge using spraying equipment can cause aerosol drift. Provided personnel spreading the sludge take account of the wind strength and direction, spray drift should not extent outside the site. (Lack, 1985).

14. Odour nuisance may be a problem close to housing or amenity areas, but the use of digested sludge should reduce this problem.

15. The risk to health due to pathogenic bacteria and viruses in sludge is very low and can be virtually eliminated by good working practices and good hygiene. However to minimise any risk of infection it is advisable to restrict public access to areas treated by aerial applications of digested sludge for 3 months and for 6 months following use of undigested sludge (Wolstenholme *et al.*, 1992).

16. There is a potential risk of water pollution with sludge application, though this should be minimal if suggested rates of application are followed, and due regard taken of rainfall, soil moisture conditions and proximity to water-courses. It is important to ensure that discharge to surface waters does not occur; United Kingdom water quality standards (Gardiner and Mance, 1984) may be contravened if it does. Sewage sludge should not be applied when the ground is frozen.

17. The gross debris some raw sludges contain may make them unsuitable for applications in woodland other than as a pre-planting application which can be ploughed in.

Conclusions

18. Most sewage sludges can safely be applied to amenity and reclamation tree plantings, with likely benefits of increased nutrient uptake and growth. There is little risk of pollution or toxicity at the rates of application recommended if ground conditions are dry and unfrozen. Sludge can be applied using equipment commonly available, though more specialised equipment may be required for sites with access problems. On poor soils, sewage sludge could, to a large extent, replace artificial phosphorus and nitrogen fertilizers.

19. A Manual of Good Practice for the Use of Sewage Sludge in Forestry (Wolstenholme *et al*., 1992) should be consulted before making sludge applications to woodland areas. It discusses the safety

and environmental aspects of sludge use, and gives information on consultation procedures, and on legal and health aspects.

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