Effect of applying sewage sludge to SRC willow

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Short Rotation Coppice (SRC) Willow has potential for the bioremediation of high nutrient waste streams. Currently in Northern Ireland raw sewage sludge cake is being applied to growing crops of SRC willow at rates of around 74t ha^{-1}, normally during the first year of re-growth following coppicing. The sludge is about 30% dry matter and is applied using a specially adapted machine which injects the sludge into the soils to a depth of approximately 50 cms.

In a replicated trial, sludge was applied to plots of one of six *Salix* spp. varieties – 'Stott', 'Parfitt', 'Olaf', 'Tora', 'Torhilde' and 'Sven', at rates equivalent to 37t ha^{-1}, 74t ha^{-1}, 118t ha^{-1} and 128t ha^{-1} between July 2005 and March 2006. The chemical analysis of the sludge was variable depending on the batch. However the dry matter was between 21 and 32% and had a pH of 5.6 to 7.0. There was 2.2 – 2.34% nitrogen in the dry matter. Levels of calcium (8158 mg Kg^{-1}), potassium (8334 mg Kg^{-1}), phosphorus (11,270 mg Kg^{-1}) and iron (4330 mg Kg^{-1}) were relatively high. Water samples were obtained from boreholes within each plot throughout a 2 year period. Soil samples were also taken for analysis annually. In December 2006, i.e. after two years growth the plants were harvested and dry matter yield obtained for each variety with each sludge application.

All of the *Salix* spp. varieties produced a greater dry matter yield with the lowest application of sludge 37t ha^{-1}, compared to no sludge. However, with the exception of 'Tora' additional levels of sludge application, even up to 128t ha^{-1} did not result in significant yield increases. Analysis of borehole water was inconclusive but there was little evidence that there were elevated levels of total nitrogen (TON) in the plots receiving high levels of sludge.

The implementation of the European Union Nitrates Directive (91/676/EC) in 2007 has meant that a maximum of 34t ha^{-1} of sludge may be applied to soil. This at least doubles the area of SRC willow required to treat the same quantity of material. Compliance with further legislation (Safe Sludge Matrix) requires a pre-treatment of the sludge in order to reduce the pathogen numbers. The required 99% pathogen kill can be achieved using lime (Ca0). Addition of 10% or 25% lime on a dry weight basis resulted in an immediate rise in pH to >11.5 with an associated immediate drop in numbers of *Eschericha coli.* When the sludge was mixed (25%) with cement kiln dust, a waste product from the local cement factory the pH was raised to ~10.0 with the required pathogen kill occurring within 4 days. Treatment with lime cement dust resulted in ammonia release, which has to be managed, and which also resulted in nitrogen loss. This potentially could permit higher levels of sludge to be applied to the willow. Treatment with lime or cement dust may achieve the necessary pathogen kill, but the application of such a high pH material to the soil may have an adverse effect on the plants. This will be monitored following lime treated sludge application in spring 2007. The use of cement kiln dust is an attractive approach as it is dealing with a second waste product, although it is necessary to ensure that it contains no potentially waste elements which may have an adverse environmental impact. Sites where sludge has been applied over a period of time are also being monitored for environmental changes which will indicate the sustainability of this approach for sewage waste management.