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Digestate and ash as alternatives to conventional fertilisers: Benefits and threats to soil biota

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Recovering energy and nutrients from waste offers opportunities to tackle issues of energy and food security whilst simultaneously improving waste management. Waste materials from the bioenergy industry potentially contain valuable resources for use in agriculture and there is growing evidence to suggest that the use of digestate, from anaerobic digestion, and biomass ash from incineration processes could contribute to improving soil health and nutrition.

The work presented here is part of the Adding Value to Ash and Digestate (AVAnD) project which looks at the impacts of digestate and ash blends on soil fertility, crop yields and soil health. Whilst increased crop productivity is one of the essential indicators of the success of these alternative soil amendments; it is important that the impacts on soil biological function is understood. Field and lab experiments were conducted with a number of different fertiliser treatments, including conventional fertiliser (urea and superphosphate), digestate from two contrasting feedstocks, ash material and ash-digestate blends. Looking across different biological scales from soil microbe to soil macro-fauna, this work examines the benefits and threats to soil biota arising from the use of ash-digestate fertilisers in agriculture.

Measurements of microbial respiration and biomass (by chloroform fumigation) and community composition (by phospholipid fatty acid analysis) were made at different timescales (days/weeks). Data from these studies demonstrates that none of the soil amendments decreased microbial activity or biomass in the short term (t= 1 month). Additions of both conventional fertilisers and the fertilisers derived from waste stimulated microbial activity with significantly higher respiration observed from the digestate based treatments. Digestate-based treatments also resulted in higher soil microbial biomass and differential effects were observed between digestate amendments with and without ash. These results will be discussed in the context of microbial community change in response to the amendments.

At the macro-fauna scale, effects of amendments on earthworm (*Eisenia fetida* and *Lumbricus terrestris*) health were assessed using 14 day toxicity assays (4 application rates between 85-340 kgN.ha^{-1}) and with 48 hour avoidance tests. In general, the addition of digestate-based fertilisers resulted in no observable toxic effects and earthworms did not significantly avoid these materials when compared to a conventional fertiliser. However, earthworms mortality was observed with one of the ash-digestate blends applied at 340 kgN.ha^{-1}, potentially linked to changes in soil pH and elements speciation .It is therefore crucial that the effects of the amendments on soil properties, and the implications this has for soil communities at all scales, is understood to ensure sustainable soil management in agriculture.