Municipal organic wastes in crop production

According to TEAGASC research, composted municipal wastes have significant potential as a valuable resource for Irish agriculture.

Each year 300,000 tonnes of food in Ireland enters the waste management system. If treated correctly, this material can be utilised as a valuable nutrient resource, as well as protecting soil health. EU Directives stipulate that all member states must divert increasing quantities of untreated organic wastes from landfill, to reduce the production of greenhouse gases caused by the anaerobic breakdown of organic matter. It is stipulated that organic waste should be treated, and composting has been shown to be one of the most cost-effective treatment measures available.

Value of composting

Composting is a process that utilises heat and oxygen to stabilise and reduce organic material to approximately 40-60% of its original volume. As the treatment process is aerobic, carbon dioxide is the primary gas produced, as opposed to methane from organic waste when it decomposes in an anaerobic environment.

Quality organic resources such as food waste compost deliver many benefits to soil, in terms of improving soil structure, liming effect and nutrient supply. When composting material, it is usually necessary to add a number of different feedstocks to achieve the optimal carbon:nitrogen (C:N) ratio (30:1) for the quickest and most efficient composting process. Therefore, composts are usually a mixture of a number of different primary feedstocks. A greater understanding of the impact of these primary (initial) feedstocks in heterogeneous composts, on compost quality and nutrient release from the resultant composts, is required. It is likely that, given current production practices, much of the composted food waste is destined to be spread onto land and, therefore, it is necessary to gain a greater understanding of the nutrient release characteristics of these materials, to increase farmer confidence in substituting inorganic fertiliser with these composted materials. Our study of 25 nationally and internationally sourced composts looked to identify these characteristics as well as identifying additional benefits to applying composts to crop-producing soils, beyond direct fertiliser value.

The role of humic substances

Humic substances (HS) are part of the stable organic matter in composts. During the composting process there is an increase in the accumulation of HS as lignin breaks down and its degradation products combine to form increasingly recalcitrant molecules. Due to the favourable properties of these compounds and their role in C sequestration, they are considered a quality criterion for compost. HS were affected by compost feedstock, with green waste composts generally having the highest mean level of HS (229.6g/kg). Food waste composts (n=12) had slightly lower average levels of HS (194g/kg); also, food waste composts with the highest HS levels were those with a significant green waste content. HS are related to the lignin content (R^2=0.71; $p<0.01$), which is highest in green waste and biowaste composts. Manure-

Table 1: Nitrogen uptake results correlated with NDF, lignin and C:N ratio.

	NDF %		Lignin %		C:N ratio	
	R^2	p value	R^2	p value	R^2	p value
Harvest 1	0.81	<0.01	0.74	<0.01	0.17	>0.05
Harvest 2	0.83	<0.01	0.91	<0.01	0.01	>0.05
Harvest 3	0.64	<0.01	0.79	<0.01	0.02	>0.05

based composts had the lowest levels of HS (90.5g/kg) of the composts tested. Generally, the results indicate that where green waste was a component within the initial compost feedstock, HS content was elevated.

Measuring carbon and nitrogen availability

Canadian studies have indicated that applications of 5-10t of compost per hectare per year have been shown to balance the yearly impact of intensive cropping systems, with long-term compost application increasing soil C content.

The C content of food waste composts was found to be high (311.4g/kg); however, it was the quality of that C that impacted on nutrient release from composted wastes. C:N ratio is commonly used as a descriptor of compost quality, but also as a means of predicting N availability. However, this approach was largely developed for organic materials of a homogenous nature, such as spent mushroom compost. As the materials from waste sources are far more heterogeneous, it was found that both neural detergent fibre (NDF) and lignin content were more accurate in predicting N availability from these materials (**Table 1**). Overall, the availability of N from composted biowastes is low (approx. 8% of total N in the initial harvest); however, over 24 months, 23% of the total N added in compost form was utilised by plants. When you compare composts made from common municipal wastes, such as catering/food waste and brown bin waste, there was a 19-33% greater uptake of N from pure food/catering waste composts across all harvests, indicating that input feedstock may be affecting release. Even so, commercial growing practices would require the application of an alternative or inorganic N source. Plant growth experiments indicated that once the compost is moderately stable, plant uptake of N from inorganic sources was not affected.

Phosphorus content

Plant uptake and availability of phosphorous (P) from composted wastes from growth experiments was higher than expected, and compared favourably with single super phosphate (SSP). While composted animal manures had the highest availability of P, there were no significant yield differences when biowastes were applied, on the basis of their total P content, to plants whose P fertiliser was applied as SSP at a comparable rate. This finding suggests that compost application rates should be considered on the basis of their P content.

Conclusions

Composted wastes provide a significant quantity of macro and micro nutrients, while also improving soil structure and soil health. All composted wastes tested over a two-year period displayed a high availability of P and could potentially replace inorganic P to a significant extent. N availability was low and the continued practice of applying composted heterogeneous wastes on the basis of their C:N ratio seems inefficient, particularly where, with composts of heterogeneous feedstock, lignin content or NDF was shown to be optimal in predicting N release. Composted municipal wastes such as food and catering wastes are a valuable resource, which could be utilised more fully in Irish agriculture, helping to sustain intensive cropping systems.

Authors

Michael Gaffney
Senior Research Officer, Horticulture Development Department, Teagasc Ashtown, Dublin
Correspondence: michael.gaffney@teagasc.ie

Alan Lee
Post-Doctoral Candidate, Dublin City University

Munno Prasad
Compost Research and Advisory, Naas, Co. Kildare

John Cassidy
School of Chemical and Pharmaceutical Sciences, Kevin St, Dublin Institute of Technology