Small-scale home composting of biodegradable household waste: Overview of key results from a three year research programme in West London

Abstract

Home composting (HC) is recognised by both local and national Governments for its contribution to reducing household waste disposal in landfill. However, the quantitative impact of HC on the diversion of household waste from landfill is uncertain. An overview of key results is presented from a three year research programme on HC in the West London area of Runnymede Borough Council (RBC), Surrey, UK. The amount of biodegradable household waste diverted from landfill disposal by HC was measured in a two year monitoring study involving 64 homeowners. The total average annual waste input to a standard 290 l HC bin was approximately 370 kg per household. The average relative mass inputs of kitchen, paper and garden waste were 29, 2 and 69 %, respectively. A survey of the Study Area indicated that approximately 20 % of households were engaged in HC and, based on inputs to HC bins, this corresponded to an overall recycling/diversion rate equivalent to 20 % of household biodegradable waste. Temperature and gas composition measurements indicated organic matter decomposition by HC was aerobic and only traces of CH_4 were occasionally detected. A field trial examined the end-use of composted products for the growth of *Petunia grandiflora*. Flower production increased with home produced composts compared to peat-amended or untreated control soil. Compost chemical composition, bioaerosol emissions and vector attraction were also investigated.

Keywords: Home composting, biodegradable municipal waste, heavy metal, bioaerosol, vector attraction, plant growth

Introduction

Biodegradable materials (garden waste, kitchen waste and waste paper/card) represent 55 % of the total quantity of municipal solid waste (MSW) deposited in landfill in England (Defra, 2007a). It presents potentially a significant environmental problem because anaerobic decomposition of biodegradable organic matter is responsible for the principal pollution risk and greenhouse gas emissions associated with landfill disposal of waste. The European Landfill Directive (CEC, 1999) has established mandatory targets for the phased reduction of biodegradable municipal waste (BMW) disposal to ultimately reduce the amount of landfilled BMW to 35 % of that produced in 1995.

Many homeowners with gardens traditionally compost and reuse their garden waste. Encouraging and expanding participation in home composting (HC) schemes has major potential advantages by providing a low cost approach to waste management and facilitating the sustainable recycling of biodegradable organic waste. Indeed, over 75 % of local authorities responsible for household waste collection/disposal in England and Wales have promoted HC through subsidised schemes and probably of the order of 3.5 million bins have been distributed nationwide since the mid-1990s. However, national Government has been reluctant to formally recognise and account for HC within local authority waste performance indicators (Defra, 2007b) due to uncertainty and the difficulties in quantifying the actual diversion of biodegradable waste from landfill disposal achieved by HC. The lack of direct financial or other incentives in the performance targets for HC may, in practice, potentially discourage proactive support for HC schemes (Slater *et al*., 2001).

Composting is the aerobic microbial degradation of bulky biowaste, which usually generates heat, and produces a stabilised organic residue with significant value as a soil conditioner. There is general guidance available on HC procedures (HDRA, 2000; The Composting Association, 2006). However, the processing and stabilization of waste in small-scale composting systems has received little scientific investigation or optimisation to increase its effectiveness at biodegradable waste treatment.

The principal aim of the research described here was to quantify the amount of waste deposited in HC bins by homeowners based on a 2 year monitoring investigation within the suburban West London setting of Runnymede Borough Council (RBC), Surrey. Other objectives of the programme of research were to:

- Determine the key processes and management factors controlling biodegradation of waste in small-scale compost bins;
- Determine the chemical quality of the composted material;
- Investigate potential bioaerosol emissions and nuisance due to vector attraction;
- Assess the end-use of the material as a soil conditioner and fertiliser product;

This paper presents a summary and overview of the key findings of the research on small-scale HC of household biodegradable waste under representative domestic conditions.

Materials and methods

Compost bin type and distribution

The HC Study Area was based on 3 refuse collection rounds in the Chertsey, Thorpe and Hythe areas of Runnymede, Surrey, UK. A promotional leaflet was distributed to almost 4,000 properties in the Study Area in March 2000 offering a subsidised compost bin. The compost bins had a capacity of 290 l and were of the Milko Premium model, fitted with a base section, removable side access panel and hinged lid with a ventilator (Straights Recycling Systems Ltd, Leeds).

Waste inputs and diversion from landfill

From the total number of households surveyed, 64 agreed to participate in a two year monitoring programme. The number of households agreeing to participate in the study was small relative to the total number targeted and those requesting bins, but this was to be anticipated given the level of commitment and self-monitoring required. Nevertheless, the group was representative of the households and property types within the Study Area as a whole.

Experimental treatments were assigned in factorial combinations to each household by dividing the group according to garden size into small (average = 38 m^2) and large (average = 95 m^2) size classes. Additional treatments were randomly assigned within each garden size class and included: +/- mixing, +/- proprietory composting accelerator compound, +/- earthworm inoculation. There were 32 households assigned to each main treatment group. Homeowners were responsible for mixing and addition of the accelerator. Mixing of the bin contents was typically practiced at intervals of 1 to 4 weeks. Two accelerator products were used, initially for the first year a liquid formulation was applied (Compost Maker, Biotal, Cardiff) and this was replaced by a dry type (Garotta, William Sinclair Horticulture Ltd, Lincoln) in the second year. Both were added to the bins following the manufacturers recommendations. Earthworms (250 g of *Dendobena* sp and *Eisenia* sp, supplied by a commercial vermiculture specialist: Darryl Poulson, Crimbles Farm, Bury St Edmunds) were added to the designated bins in July – September 2000. Homeowners were supplied with experimental equipment to record the amounts of kitchen, paper and garden waste placed in the compost bins and they began adding and measuring the input of waste to the bins in May 2000.

A mass balance was produced for each compost bin at the end of the first (May 2000-April 2001) and second (May 2001 – March 2002) year. The material in each compost bin was removed in three distinct layers based on the extent of decomposition (upper - fresh (A), intermediate - semi-decomposing (B) and lower - compost (C)) and the mass of each layer was weighed in buckets using a hanging scale. Representative composite samples from each layer were collected to determine the moisture content and material from Layer C was subjected to a more extensive suite of chemical analysis.

Composting process

Temperature and gas measurements of materials undergoing decomposition were obtained to provide information on the condition and quality of compost and to indicate the nature of the biochemical processes operating within home compost bins. Homeowners were supplied with a soil/compost temperature probe (0-80 ºC) and regularly recorded the temperature of material in the compost bins. This was complemented with more detailed monitoring of temperature conditions and gas profiles using an electronic thermometer and portable gas meter (GA2000, Geotechnical Instruments, Leamington Spa, UK) fitted with a sampling probe. Profile temperature data were recorded to a depth of at least 80 cm and four replicate gas measurements were recorded at a depth of 40 cm, approximately at the mid-point of the mass of material in the bin to avoid gas short-circuiting due to the sampling pump. Gas monitor readings were stable following this approach and did not indicate significant by-pass from the ambient atmosphere. Profile measurements were completed on 6 occasions during the experimental period and representative temperature data for September 2001 are presented and discussed here.

Chemical properties

Standard laboratory procedures were followed to measure a suite of chemical determinands in the decomposing materials sampled from HC bins (MAFF, 1986; SCA, 1986a,b). The moisture and organic matter contents were determined by drying overnight in a forced-air oven set at 105 ^{o}C and by the loss-on-ignition at 375 ^{o}C, respectively. Total concentrations of N and P were measured after Kjeldahl digestion and diluted digestates were aspirated onto the manifold of a colorimetric segmented flow autoanalyser (San Plus, Skalar Analytical B.V., Breda, The Netherlands). Total K, Mg, Zn, Cu, Ni, Cr, Pb and Cd were measured using an atomic absorption spectrometer (5100 PC Spectrometer, Perkin-Elmer, Waltham, Massachusetts, USA) after hydrochloric-nitric acid digeston. Concentrations of NH_4-N, NO_2-N, NO_3-N were measured following a standard 2 M KCl extraction procedure by automated colorimetric techniques and the extractable P concentration was also measured autocolorimetrically on sodium hydrogen carbonate extracts. The pH and electrical conductivity values were measured by standard methods using appropriate electronic devices and electrodes.

Bioaerosol emissions

Emissions of bioaerosols, particularly of the thermophilic fungus, *Aspergillus fumigatus*, which is a native member of the microbial community in composting waste, have been linked with potential impacts on human health from the large-scale centralised composting of biodegradable waste (Swan *et al*., 2003). To determine if HC represented a potentially hazardous exposure to bioaerosols, culturable *Aspergillus* spp. were measured adjacent to home compost bins during dismantling of the 64 bins in May 2002. *Aspergillus* spp. were collected using a portable single stage bioaerosol impact sampler for agar plates (Burkard Manufacturing Co Ltd, Rickmansworth, UK) on a malt extract culture medium in a 90 mm plate through a sieve with 100 apertures of 1 mm diameter. Sampling was performed for a duration of 20 minutes at a constant flow rate of 20 l min^{-1}. The sampler was mounted at the hinge of the bin lid to represent the average potential respiratory exposure of an individual working over the bin. Exposed plates were stored in a cool box immediately after collection and were transferred to a laboratory incubator maintained at 4 ^{o}C. *Aspergillus* spp. were determined by inverting the plates and incubating at 40 ^{o}C for 12 h. Typical colonies were confirmed as *A. fumigatus* and *A. niger* by microscopical examination.

Vector attraction

A simple study was designed to quantify the association of fruit flies with HC activities, as homeowners identified this as a potential source of niusance. Proprietary pheromone insect fly traps were placed inside and at distances of 1 m and 2 m from the compost bins and the traps were removed after periods of 1, 3, 5 and 10 days. The effects of lid position (open or closed) and small or large garden size (which was expected to influence the proportions of deposited food and garden waste) were examined on the numbers of flies within the vicinity of the bins. There were 10 replicate bins examined for each garden size class and each group was divided equally to test the effect of lid position on fly numbers.

Plant growth field trial

A field experiment was established on a sandy loam soil (pH value, 6.2; organic matter content, 3.8 %; cation exchange capacity, 7.9 me 100 g^{-1}) to assess the end-use of home compost as a soil conditioner for the growth of *Petunia grandiflora* F_1H. Composted material collected from bins managed by the same experimental treatment was combined and applied to experimental plots with dimensions of 1.5 x 1.5 m (2.25 m^2). The treatments were replicated three times in randomised blocks. The dry solids contents of the composts were determined and the materials were added to the plots at a rate equivalent to 2 kg m^{-2} (dry matter). Compost was applied to the plots by hand and incorporated to a depth of 10 cm using a pedestrian operated rotary cultivator. A control plot received a dressing of sphagnum moss peat (Shamrock, Bord na Móna Plc, Newbridge, Ireland) at an equivalent dry matter loading and a second control was maintained in an untreated condition. Twenty five container-grown plants, raised without controlled release fertilisers, were transplanted into each plot at a spacing of 30 cm. Flowers were counted and removed on a weekly basis during the monitoring period between June-August 2001. No attempt was made to balance the plant nutrient provision of the compost or peat-amended plots as it is difficult to match nutrient availabilities in different organic residuals in practice and also the objective was to provide a gross comparison of the effects of the different soil amendments on soil improvement and plant growth response.

Results and discussion

Scheme participation

Home composting is a voluntary activity and participation depends upon the willingness and attitudes of homeowners. The total number of requests for compost bins was 838, suggesting a participation rate in the HC scheme equivalent to 21 % of the households in the Study Area. This was below the proportion of households with gardens undertaking HC nationally in England, which increased from 27 % in 1997 to 35 % in 2005 (Defra, 2007b).

Waste inputs and diversion from landfill

Monthly and annual total waste inputs per household to the 64 compost bins are summarised in Table 1. The total average annual input per household was approximately 370 kg. This value is approximately four times larger than the default value assumed for diversion of biodegradable waste by HC of 100 kg y^{-1} (DETR/WO, 1999) or the predicted removal of biowaste from the residual waste stream by HC equivalent to 87 kg per household (Parfitt, 2006). The average monthly deposits of kitchen and garden wastes were 9 kg and 21.5 kg, respectively, although, as would be expected, there was a seasonal trend in garden waste inputs (Figure 1). The relative contribution of kitchen, paper and garden waste to the total average waste input was 29, 2 and 69 %, respectively. Kitchen waste represents approximately 17 % of the household waste disposed to landfill in England (Defra, 2007a) and amounts to 87 kg per person y^{-1}, assuming an average amount of waste disposed per person of 511 kg y^{-1} (Defra, 2007a). The majority of households engaged in HC in RBC were occupied by 2 people and the average amount of waste collected for disposal by the local authority was in line with national statistics and equivalent to 1.1 t per household (pers. com. D. Speight, RBC). Therefore, HC reduced the disposal of kitchen waste for collection by approximately 60 %. Garden waste represents 20 % of the collected residual waste (Defra, 2007a), and was therefore estimated to be equivalent to 220 kg per household in RBC. This value is less than the average annual amount of garden waste deposited in HC bins for the 64 households in Runnymede, which was 258 kg. Householders often have a surplus of garden waste for disposal and this can be by a variety of methods including: HC, transport to a centralised collection and composting site, burning, or disposal in the residual waste bin. Therefore, in contrast to HC of kitchen waste, which represents a direct diversion of biodegradable waste from landfill disposal, the impact of HC on garden waste disposal is more difficult to ascertain from measurements of waste inputs to compost bins. Indeed, homeowners who compost their waste may also change their behaviour in other ways, for example, a survey of households involved in the HC project indicated that they transported garden waste less frequently to the centralised collection site compared to homeowners that did not compost their waste at home. Thus, it is plausible that homeowners could also utilise the spare capacity in the residual waste bin generated by HC to dispose of surplus garden debris.

The average moisture and dry matter mass balance for the bins determined for the two-year monitoring period is illustrated in Figure 2. This analysis was based on the average moisture and dry matter contents in the three distinguishable layers (A, B and C) in the bins according to the degree of decomposition. The longest residence time for the most decomposed material in the bins was up to 1 year. The results showed that 54 % of the fresh matter deposited in the bins was removed through moisture and volatile solids losses during the composting process, equivalent to 127 kg (34 %) and 74 kg (20 %), respectively, of the annual waste input (370 kg). Within a suburban setting, such as RBC, these results indicated that, overall, HC could potentially divert up to 20 % of the biodegradable household waste stream based on the inputs to HC bins measured here and assuming that approximately 20 % of the community were actively engaged in HC. The results from direct participation studies should be viewed with a degree of caution, however, as arguably these homeowners may be more motivated composters compared to the average HC population, leading to an overestimate of diversion rates. Nevertheless the results demonstrate what is practically achievable by effective HC schemes.

Composting process

Temperatures recorded by homeowners were highly variable, but there was an underlying seasonal trend relating to ambient temperature conditions (Figure 3). Temperature profiles generally varied between 6-50 ºC and were usually above ambient in the psychrophilic (0 – 20 ^{o}C) to mesophilic (20 – 45 ^{o}C) ranges, indicative of active biological degradation. The warmest conditions were generally measured in recently deposited waste, associated with high rates of microbial activity in this layer, and temperatures declined with increasing depth in more stabilised material (Figure 4). Oxygen concentrations were typically close to ambient values and in the range 15 – 21 % at a probe insertion depth of 40 cm, with overall mean values for each sampling event in the range 18.4-20.1 %, indicating that waste degradation was predominantly by aerobic processes.

Traces of CH_4 were occasionally detected by interstitial gas analysis suggesting that anaerobic zones may develop within the composting mass. Some production of CH_4 is plausible given the heterogeneity of the input materials and variations in densities and moisture contents of input wastes. A potential criticism of the technique used to monitor the interstitial gas is that the analysis system was insensitive to very small concentrations of CH_4 (limit of detection = 1.0 %). Nevertheless, the results were entirely consistent with other data indicating that HC does not generate significant amounts of CH_4 (Wheeler and Parfitt, 2002). Methane release to the environment from home composters is probably controlled and minimised due to the microbiological oxidation of CH_4 in the mainly aerobic environment within the bin. Biological CH_4 oxidation is accomplished by methanotrophic bacteria that are ubiquitous in water and soil environments (Hilger and Barlaz, 2002), they are abundant at the interface between aerobic and anerobic zones and would therefore also be expected to be part of, and active in, the microbial community in composting wastes (Jakel *et al*., 2004). Consequently, HC is unlikely to be a significant source of CH_4 emissions to the environment. Mixing reduced detectable CH_4 concentrations, but in general, the different management practices tested (garden size, mixing, addition of composting accelerator or earthworm inoculum) had little or no overall effects on composting activity. It appears that the natural ecological and degradation processes occurring within home compost bins are effective in decomposing regular inputs of kitchen and garden waste over the course of a year and commonly recommended HC management techniques have little measurable benefit in practice.

The stabilisation of frequent inputs of small amounts of mixed organic residues to small-scale composters does not follow the normal ecological progression observed with conventional batch-operated, centralised composting systems. Waste treatment in small-scale units is highly biodynamic and organic matter is simultaneously present at different stages of decomposition, which also depends on the activities of invertebrate animals, particularly earthworms. The results presented here demonstrated that the regular input of complex mixtures of different waste types (kitchen, paper and garden waste) to small-scale composting systems provided a stable and overall aerobic environment that was effective for biodegradation of putrescible household solid waste.

Compost quality

Samples of composted materials (Layer C) collected each year during the dismantling of the compost bins were analysed for a suite of chemical determinands (Table 2). The contents of major nutrients were generally larger than those typically reported for centralised composting (The Composting Association, 2001). This could be explained because woody plant remains of low nutrient status are generally excluded from small-scale home composters, which are mainly supplied only with soft plant tissues of higher potential nutrient value as a feedstock for composting. No statistically significant effects of garden size or bin management treatment on the chemical properties of the residual compost were detected by ANOVA. Large variations observed in the nutrient status of home produced compost samples (Table 2) could be related to the extent of fertiliser use by individual homeowners in the garden and the nutrient content of plant debris, which was the main waste input to the bins.

Heavy metal concentrations were measured in the composted residue (Layer C) collected from the bins in May 2001. Comparison with the metal limits in BSI PAS100 (BSI, 2005) showed that, on average, the metal content was below the respective limit values (as mg kg^{-1} dry solids (DS): Cd=1.5, Cr =100, Cu=200, Pb=200, Ni=50, Zn=400) except for Cd. The apparently high Cd value may be explained by the distribution of concentration data for this element as a large proportion of samples (56 %) contained less than the analytical limit of detection, but one sample had 16 mg Cd kg^{-1} DS and four others contained 7 – 8 mg Cd kg^{-1} DS. Biodegradation and the loss of volatile solids increases the metal concentration measured in composting biomass. In addition, metals entering home compost probably derive from the presence of small metallic fragments discarded inadvertently into the bin with the waste, atmospheric deposition onto vegetation and printing inks on waste paper, although no correlation was detected here between the amount of paper deposited in home compost bins and the total metal contents (data not shown). These sources could provide an explanation for the maximum concentrations of elements measured in home compost produced from segregated biodegradable waste that exceeded the PAS 100 limit values. Nevertheless, the data indicated that the metal contents in home compost were typically well within the PAS 100 quality criteria for potentially toxic elements.

Microbiological assessment

Airborne *Aspergillus* spp. were detected during the physical disturbance of composting material in all of the bins monitored in the microbiological investigation. The average airborne concentration of *Aspergillus* spp. was 79 cfu m^{-3} (Table 3) and a maximum value of 123 cfu m^{-3} was recorded. However, these values are significantly below the recommended tolerable concentration of 1000 cfu m^{-3}, or the exposure dose (>10^{6} cfu m^{-3}) that may cause sensitisation (Millner *et al*., 1994). Therefore, under the typical conditions represented by this study, HC does not represent a significant risk to health from airborne fungal microorganisms.

Vector attraction

Fly nuisance was the main problem experienced by homeowners involved in HC their waste. The largest numbers of fruit flies were collected by insect traps positioned inside the bins, but they became less numerous within a short distance from the bin (Figure 5). The position of the composter lid (open or closed) had little effect on fly numbers inside or in the immediate vicinity of the bins since they could exit or enter the bin through the ventilator. Fruit flies were particularly attracted to compost bins at properties with small garden size compared to large gardens. This could be attributed to the predominance of kitchen waste inputs to the home composters in small gardens, providing a favourable food source and environment for fly population development. Heat generated during the composting process promotes the metabolism and rate of growth of fruit flies and also increased the fly population. Although flies were the main nuisance reported by homeowners most found it to be tolerable because the flies were only present in the immediate vicinity of the compost bin. Fruit flies are advantageous to waste degradation in HC and increase organic matter decomposition by feeding on fermenting fruit and vegetation. When present, they remain in close proximity to the food source within the compost bin and are therefore unlikely to cause a general nuisance or risk to health.

Field trial

The effects of compost application to soil on the growth performance of *Petunia grandiflora* F_1H were assessed using a flower counting technique. All experimental plots receiving home produced composts gave larger flower numbers than either peat-amended soil or the untreated control (Figure 6) and flower production increased significantly in linear relation to the rate of nutrient (N, P, K, Mg) addition to the soil in the composted residues (Figure 7). This was a function of compost nutrient content since an equivalent rate of dry matter was applied to all amended plots in the field experiment (2 kg m^{-2}). Although the mineral N content of peat was approximately 3 times larger than the amount of soluble N measured in home compost, the increased plant growth response was explained because the total contents of major nutrients were approximately 10 times larger in compost compared to peat (Table 4). The results demonstrated the effectiveness of home produced composts as replacements to straight peat soil conditioners for general horticultural use as soil improvers in home gardens.

Conclusions

This research programme has quantitatively assessed the potential diversion of household biodegradable waste from landfill disposal by HC, waste biodegradation processes in small-scale composters, bioaerosol emissions, vector attraction and the end-use of the compost. In urban areas, where homeowners have access to garden space, HC could potentially divert 20% of the biodegradable household waste stream from landfill disposal if approximately 20 % of the community were actively engaged in HC, based on the inputs to HC bins recorded here. Thus, HC has a significant role in diverting household waste from landfill disposal and the results from this study fully support proposals to include HC in local authority waste performance targets (Defra, 2007b). A possible criticism of the work reported here, however, is that the removal of garden waste from residual waste collection by HC cannot be reliably estimated from measurements of inputs to HC bins. This is because most households with gardens generate a surplus of garden waste that can be disposed or reused by a variety of methods and the waste can be displaced between these different routes. Therefore, a further phase of work has measured the direct impact of HC on the amount and composition of collected residual household waste and this will be reported in a future publication.

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Table 1

Monthly and annual waste inputs to home compost bins (n = 64)

Statistic	**Kitchen waste**	**Paper waste**	**Garden waste**[(1)]
Weighted average (kg hh^{-1} $month^{-1}$)	9.0	0.8	21.5
Total annual deposit (kg hh^{-1})	108	9.6	258
Waste proportion (%)	29	2.0	69

(1)Estimated from the density of grass clippings, 200 kg m^{-3} (NRAES, 1992; The Composting Association, 2001)

hh; household

Table 2

Summary of chemical properties of home composts on a dry solids basis (n = 128, except metals = 64)

Parameter	Minimum	Maximum	Median	Mean
Dry solids (%)	17.2	75.4	33.3	30.2
Organic matter (%)	6.6	69.3	30.6	27.9
Total N (%)	1.12	6.07	3.19	3.32
Total P (%)	0.10	1.62	0.56	0.61
Total K (%)	0.42	4.15	1.45	1.59
Total Mg (mg kg^{-1})	128.5	625.7	242.3	276.4
pH	5.7	9.3	7.1	7.3
Conductivity (µS cm^{-1})	462	1618	796	859
NH_4-N (mg kg^{-1})	0.87	37.7	14.9	14.3
NO_2-N (mg kg^{-1})	0.10	3.43	0.51	0.66
NO_3-N (mg kg^{-1})	8.81	96.9	35.8	41.4
Extractable P (%)	0.02	0.17	0.06	0.06
Total Zn (mg kg^{-1})	28	693	195	240
Total Cu (mg kg^{-1})	<LOD	177	41	52
Total Ni (mg kg^{-1})	<LOD	107	14	18
Total Cr (mg kg^{-1})	<LOD	198	12	28
Total Pb (mg kg^{-1})	12	745	75	124
Total Cd (mg kg^{-1})	<LOD	16	-[(a)]	1.8

Note: <LOD indicates the concentration was less than limit of analytical detection

[(a)] Value not available

Table 3

Concentration of airborne *Aspergillus* spp. during physical disturbance of home compost

Statistic	Original colony count	Corrected colony number (Macher, 1989)	*Aspergillus* concentration (cfu m^{-3})
Minimum	10.0	11.0	36.7
Maximum	30.0	37.0	123.3
Median	21.0	24.0	80.0
Mean	20.9	23.7	78.7

Table 4

Nutrient contents (dry solids basis) of peat and home compost used in the plant growth field trial

Organic material	Total N (%)	Total P (%)	Total K (%)	Total Mg (mg kg^{-1})	NH_4-N (mg kg^{-1})	Oxidised-N (mg kg^{-1})
Min.	1.9	0.06	0.8	221	8.5	12.8
Max.	4.0	0.18	2.8	450	18.8	41.4
Mean	2.9	0.13	1.8	317	13.8	29.3
Peat	0.2	0.02	0.1	107	57.5	66.5

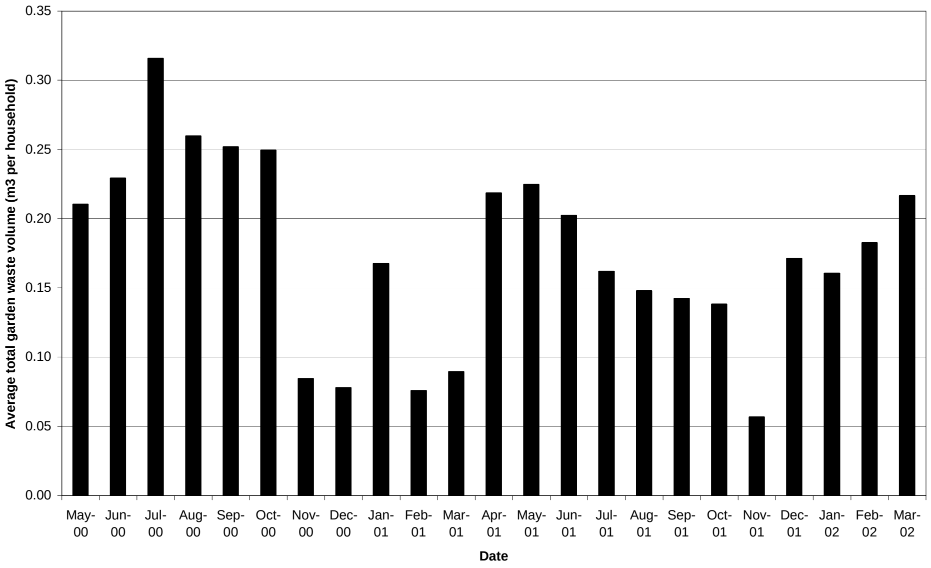


Figure 1 Mean monthly volumetric inputs of garden waste to home compost bins, May 2000 – March 2002

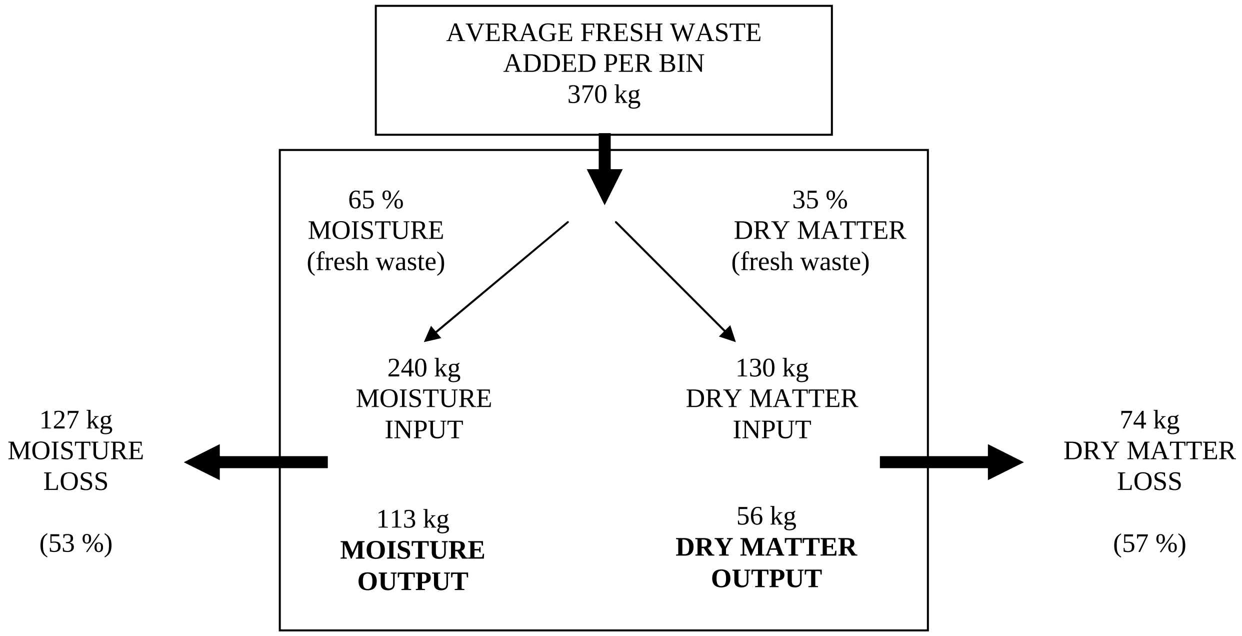


Figure 2 Annual mass balance of waste processed per 290 l compost bin. This is based on the input waste mass measured by homeowners, the mean input moisture and dry solids contents of fresh, undecomposed waste (layer A), and in the semi-decomposed and decomposed layers (B and C). The loss of moisture and dry matter is estimated from the difference between the input values and the contents of the residual materials sampled in the bins.

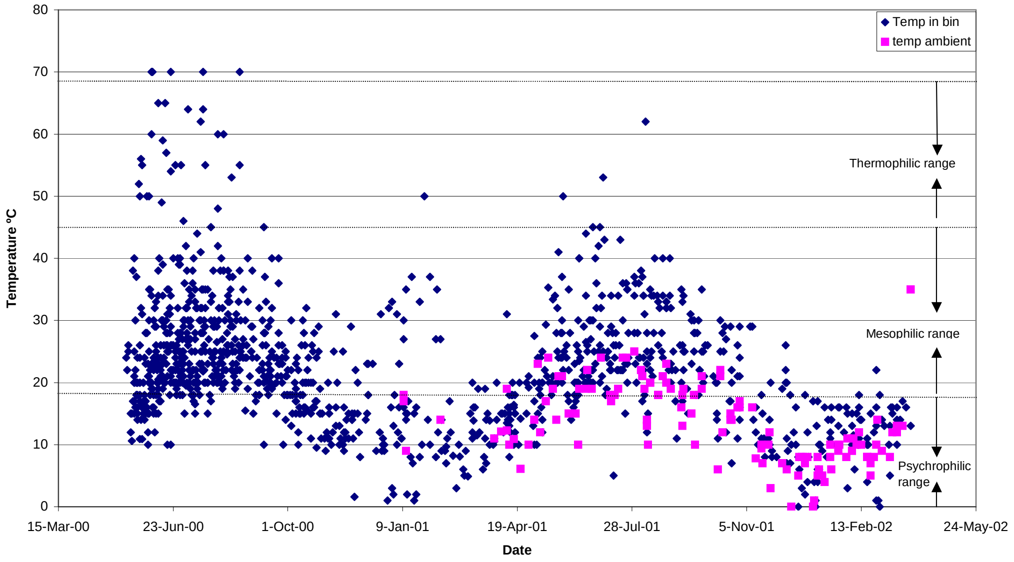


Figure 3 Compost temperature recorded by homeowners participating in the home composting study, May 2000-March 2002

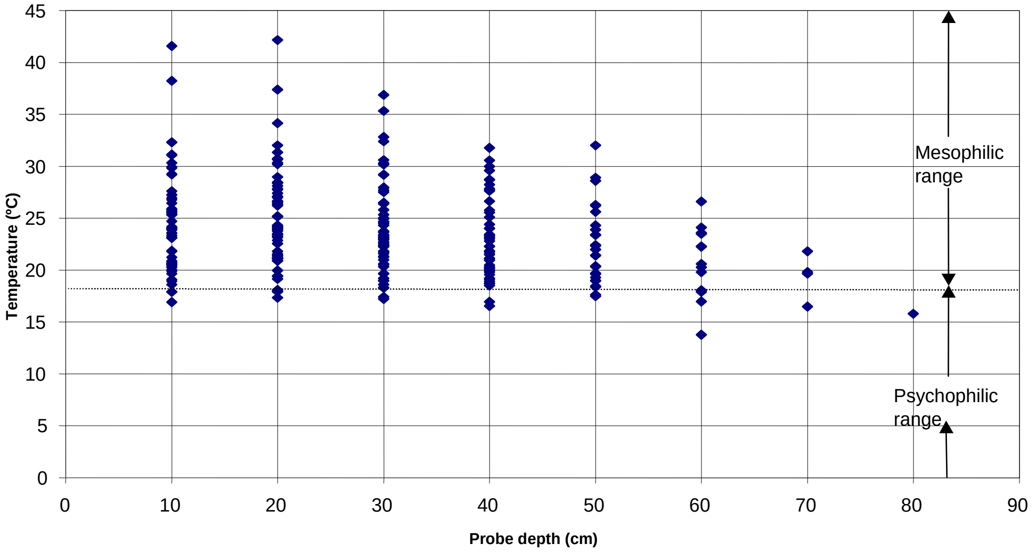
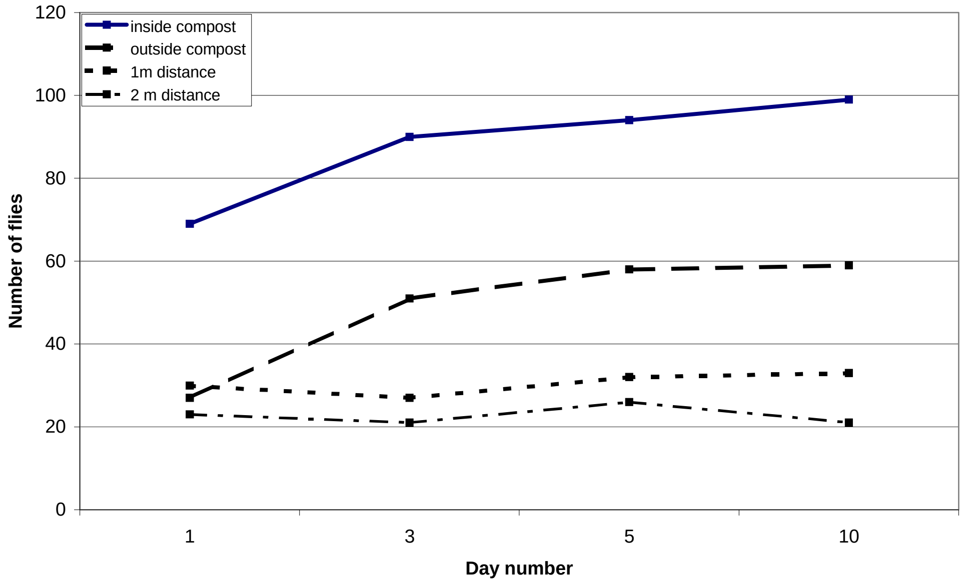


Figure 4 Compost temperature profile in relation to depth, September 2001

(a) Small garden size



(b) Large garden size

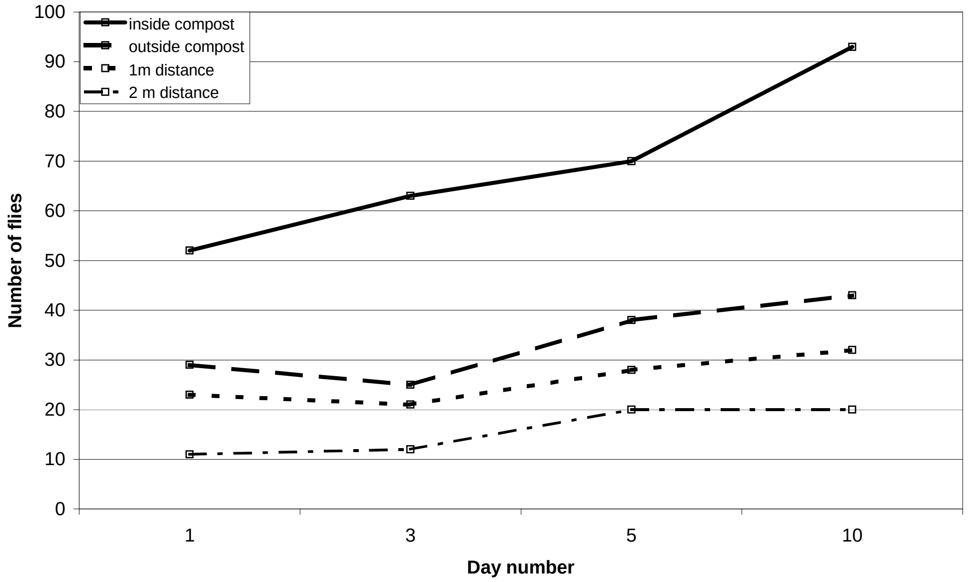


Figure 5 Mean numbers of fruit flies collected from compost bins (lids removed) in (a) small and (b) large gardens

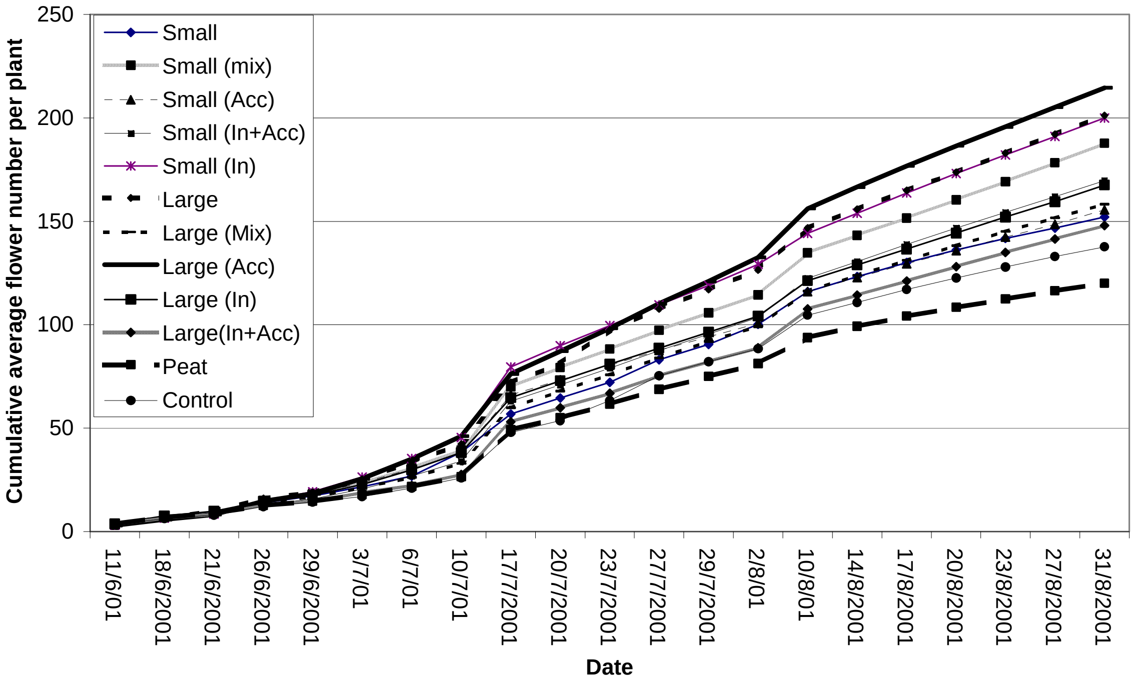
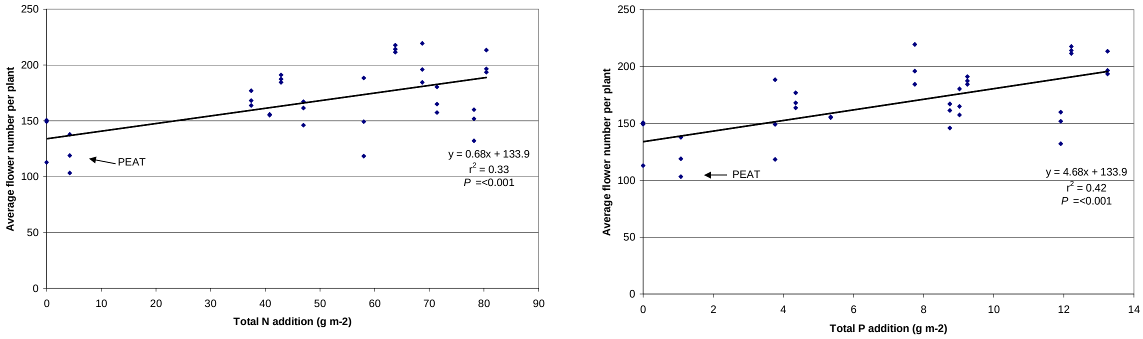
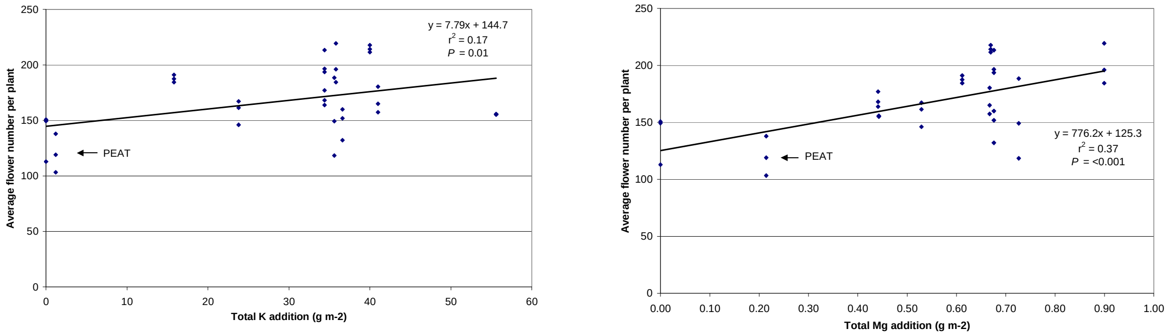


Figure 6 Cumulative flower production by *Petunia grandiflora* F_1H in sandy loam soil amended with different home produced composts relative to peat and an unamended control (compost and peat applied at a rate equivalent to 2 kg m^{-2} of dry matter); 'Small' and 'Large' indicate garden size class, 'Mix' indicates mixing, 'Acc' indicates proprietary compost accelerator applied, 'In' indicates bin inoculated with earthworms



(a) Nitrogen

(b) Phosphorus



(c) Potassium

(d) Magnesium

Figure 7 Relationships between the total number of flowers produced by *Petunia grandiflora* F_1H and rates of nutrient addition to sandy loam soil in home produced composts and peat