Using Composted Green Waste Materials in Growing Media©

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We studied the effects of mixing composted green waste (CGW) with peat on the chemical, physical, and microbial properties of the resulting growing media and on the performance of plants grown in it. Composted green waste increased the media's pH, EC, and K and bulk density and total bacterial and fungal counts. Total porosity and easily available water were reduced. The addition of young CGW to peat resulted in increased biodegradability of the peat, particularly in peat of low lignin content. Satisfactory tomato (*Lycopersicon esculentum*) seedlings were grown in media containing up to 25% CGW. Tomato seedlings grown in compost derived from a mixture of CGW, sawdust, and spent brewer's black grain, weighed 10% less than those grown in peat. Tomato seedlings grown in a 1 compost : 1 peat (v/v) mixture weighed 8% less than those grown in peat.

INTRODUCTION

The E.U. Landfill and Biowaste Directives will require the diversion of biodegradable waste from landfill disposal. Composting has been considered by the E.U. as a good alternative management strategy. There is also increasing pressure from environmental organisations to reduce the use of peat in horticulture (Carlisle, 2003). Availability of alternatives such as composted bark and coir, which can completely replace the peat content in growing media, is limited. Little work has been carried out on the use of composted greenwaste as a component of growing media (Fisher et al., 1989; Grantzau 2001; Pronk, 1995). An attempt has been made to develop a model for optimising nutrition in peat-based growing media containing composted green waste (CGW) (de Kreij and van der Gaag, 2003). Claims have been made that processed waste can be used at up to 75% to dilute peat. In this paper we report on the chemical, physical, and microbiological properties, and biodegradability of growing media containing CGW and the performance of tomato (*Lycopersicon esculentum*) plants grown in it.

MATERIALS AND METHODS

Composted Green Waste Experiments. Composted green waste from two sources was mixed with Irish moss peat at 0, 10, 20, and 50% (by volume). Before mixing, dolomitic lime (at 4 $g \cdot L^{-1}$) and PG fertiliser (at 1.5 $g \cdot L^{-1}$) were added to the peat and calcium ammonium nitrate (at 0.7 $g \cdot L^{-1}$) N and dicalcium phosphate (at 0.6 $g \cdot L^{-1}$) to the CGW. The mixes were analysed for available nutrients using a 1/1.5 water extract for pH and EC, and a 1/1.5 $CaCl_2$/DTPA extract for extractable nutrients (Alt, 1997). The physical properties of the mixes were determined using a sandbox (Prasad and NiChualain, 2004). Bacterial and fungal counts were carried out on the composted materials and peat. The standard pour plate method was used to determine mesophilic bacteria on Oxoid plate count agar after incubation for 2 days at 37 ºC. The standard spread plate method was used to determine fungal counts on Oxoid malt agar after incubation for 5 days at 25 °C. The peat/CGW mixes were filled into 11-cm pots. A tomato seedling was pricked out into each pot and grown on a glasshouse bench. Six replicates were harvested at the five-rough-leaf stage and the remainder before flowering on the first truss. Fresh weight was recorded at each harvest.

To study degradation of the growing medium over time, peat/CGW mixes in pots were subjected to irrigation and drying cycles. In Feb. 2000, the pots were placed on two ebb and flood benches in a glasshouse and periodically irrigated over a period of 24 months as deemed required by inspection of the pots. The effects of two CGWs on two peat types were studied in all four combinations but in each case the mix was 7 peat : 3 CGW (v/v). The two CGWs were either young (composted for 12 weeks) or mature (composted for 20 weeks with nitrogen addition). The two peat types were young undecomposed peat, H2 on the von Post scale, and a more decomposed peat with a van Post rating of H5. Pots of 100% peat provided the experimental control. An estimate of growing medium height was made 2 weeks after the start of the experiment to allow for initial settling and subsequent height measurements were made at 4-month intervals, except for one period from November 2000 to May 2001.

Potential of Spent Brewer's Grains. A 15 m^3 mixture of equal parts of green waste, sawdust, and spent brewer's black grain was composted over a 12-week period with nitrogen addition. After a further 2-month curing period, the compost was mixed with peat at volume rates of 0, 25, 50, and 100% to produce growing media. Each of these four treatments was filled into seven 11-cm pots and tomato seedlings were pricked out into the pots. The pots were irrigated with a complete liquid-feed solution. Plant fresh weight was recorded when harvested at the same stage as the experiment described above.

RESULTS AND DISCUSSION

Composted Green Waste Experiments. Generally the addition of CGW resulted in an increase in pH, EC, and K levels (Table 1). With the Dublin-sourced material there was a reduction in N level and in the case of the Dunbrik material there was no effect on N level. Depending on the feedstock of CGW, and the composting process, there could be N immobilization or mineralization.

The addition of CGW resulted in a large increase in bulk density and a reduction in pore space (Table 2). The addition of CGW did not result in a decrease in air content in this experiment. At the highest rate of application of CGW there was a decrease in easily available water. Recently Prasad and Ni Chualain (2004) have shown that the total fines (<1 mm) present in CGW will determine the effect on air space.

Total bacterial counts increased significantly as the amount of CGW in the medium was increased from 0% to 10%, 20%, and 50% (Fig. 1). This trend was apparent at 1- and 56-day samplings. The addition of lime and fertiliser to peat tended to increase bacterial levels. Total fungal counts also tended to increase with the addition of CGW. The increase in the microbial activity due to the addition of CGW

Table 1. Nutrient levels in composted green waste and peat mixtures.

CGW	Rate (%)	pH	EC	K	N
Dublin	0	4.8	161	165	123
	20	5.8	204	280	134
	50	6.4	178	340	81
Dunbrik	0	5.0	197	230	128
	20	5.9	232	420	130
	50	6.6	289	680	129

Table 2. Physical properties of composted green waste (CGW) and peat mixtures.

CGW (%)	Bulk density (g·L)	Pore (%)	Air % (10 cm)	Easily available water[1]
0	116	93.6	23.2	25.9
10	140	91.5	24.3	25.5
20	168	90.3	23.3	24.7
50	241	87.4	24.0	19.0

[1] Easily available water (difference between water content at 10 cm and water content at 50 cm tension).

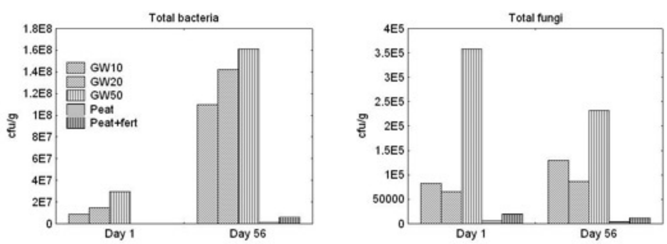

Figure 1. Total bacteria and fungal counts in peat and CGW/peat mixes over 56 days.

to peat could be an advantage in reducing the susceptibility of plants to root disease due to competition (Hoitink and Fahy, 1986).

The results of the growth experiment are shown in Fig. 2. At the first harvest, there was no effect of CGW on growth in mixes up to 20% CGW. At the 50% rate, plants growing in the Dunbrik material were severely reduced in weight. This is probably a result of the high K and EC levels in the material. At the final harvest growth was again little affected by the inclusion of CGW up to 20%. At the 50% rate, growth was severely reduced in the Dublin material while the reduction was much less in the Dunbrik material, a reverse of the result of the first harvest. Correlation between plant growth and nutrient levels in the growing medium showed a negative correlation between plant weight and EC (r^2=-0.72) and K level (r^2=-

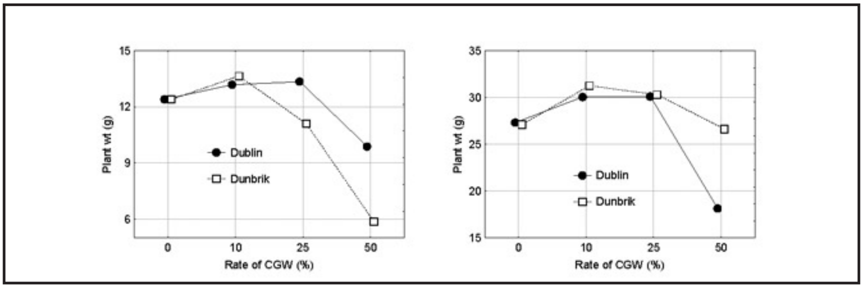

Figure 2. Effect of two CGWs on the early (left) and final weight of tomato seedlings .

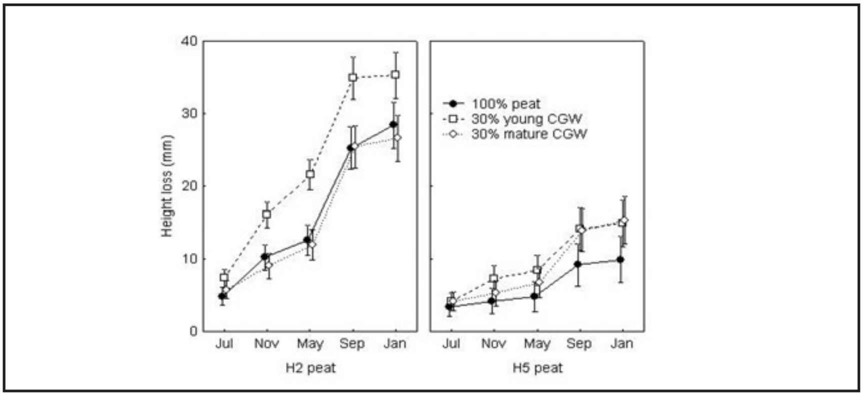

Figure 3. The effect of addition of young and mature CGW to two types of peat on the physical degradation of the growing medium.

0.86) at the first harvest. At the second harvest there was a positive relationship between fresh weight and N level (r^2=0.86). The low plant weights are clearly associated with low N levels.

In the physical structure experiment, with H2 peat, after 9 months there was an obvious effect of addition of young CGW on degradation while treatments with mature CGW were never significantly different from 100% peat (Fig. 3).

Table 3. Effect of substitution for peat with compost on the growth of tomato seedlings.

Compost rate ((% of volume)	Fresh wt (g/plant)
0	36.6
25	33.6
50	33.5
100	30.2
F-test	***
s.e.	0.90

In the case of H5 peat, adding young CGW resulted in a significant increase in degradation apparent after 9 months and maintained through the period of the experiment. The mature CGW did not increase degradation compared with 100% peat early in the experiment. However, as the experiment progressed, the differences between the mature CGW and the 100% peat treatments in H5 peat became more noticeable and at the last two dates were significantly different.

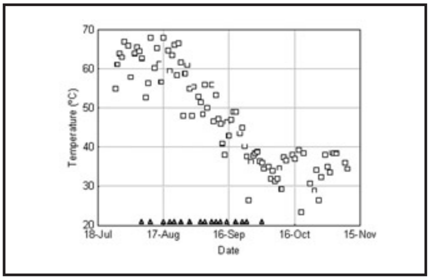

Figure 4. Temperatures during composting of green waste, sawdust and spent black brewer's grain(triangle symbols mark turning dates).

Potential of Spent Brewer's Grains. During composting of the mixture, temperature fell from an initial level of more than 60 °C down to 30 to 35 °C over a 12 week period (Fig. 4). In the growing trial (Table 3) there was a slight but significant reduction in plant size as the compost was substituted for peat up to 50% and a further reduction when used as a complete replacement. Plant appearance was normal in all treatments and it seems likely that a lower water-holding capacity in the compost was the main reason for the fall-off in plant performance.

These results illustrate some of the problems in using green waste in growing media, such as high bulk density, high conductivity and N immobilisation. However at rates below 50% and in conjunction with other waste materials it can be successfully used as a growing medium component and peat replacement.

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