THE USE OF COMPOSTED WASTE AS A GROWING MEDIUM AND PEAT DILUENT

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ABSTRACT

The effects of the addition of composted greenwaste (CGW) to peat on chemical, physical and microbial properties and on plant performance were studied. The addition of CGW resulted in an increase in pH, EC and extractable K and a reduction in extractable P. There was an increase in bulk density and a reduction in total porosity and easily available water. Total bacterial and fungal counts increased. Growing trials carried out in the mixtures showed that it was possible to grow satisfactory tomato seedlings with the addition of CGW up to 20-25%, and the plants were of comparable quality to those grown in 100% peat. The addition of young CGW to peat resulted in increased biodegradability of peat, particularly in peat having a low lignin content. In a compost derived from a mixture of greenwaste, sawdust and spent brewer's black grain, tomato seedlings showed a slight reduction (8%) in weight when the compost was used at up to 50% in a mixture with peat. A further slight reduction (10%) was found when the compost was used as a complete replacement for peat.

INTRODUCTION

The impending EU landfill and Biowaste Directive will require the diversion of biodegradable waste from landfill to a large extent. (*ad hoc* meeting EU DG Environment, 2004). Compost has been considered by the EU as a good alternative management strategy. There is also increasing pressure from the environmental lobby to reduce the use of peat in horticulture (Carlisle, 2003). Alternatives such as composted bark and coir can indeed replace peat up to 100%, however the quantity of available processed waste materials is insufficient to replace peat completely. Limited work has been carried out on the use of composted greenwaste as a component of growing media (Fisher *et al.*, 1989, Pronk, 1995, Grantzau, 2001).In addition an attempt has been made to develop a model for optimising nutrition on 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 up to 75% to dilute the peat. In this presentation we will be showing the effects of adding processed biowaste mainly CGW to peat on the chemical, physical, microbiological properties, biodegradability and plant performance.

MATERIALS AND METHODS

Composted green waste (CGW) from three sources was added to peat at 0, 10, 20 and 50% by volume. Dolomitic lime (4 g/L) and PG fertiliser (1.5 g/L) was added to the peat and calcium ammonium nitrate (0.7 g/L) and dicalcium phosphate (0.6 g/L)N 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 (Maher et al., 2001, 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°C. 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 they were grown on a glasshouse bench. Six replications 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 February, 2000, the pots were placed on two benches in a glasshouse compartment which were irrigated by an ebb and flood system until the experiment was terminated in January 2002. Irrigation was given as deemed required by inspection of the pots. There were three CGW treatments, a control, (100% peat), and an addition of either young (composted for a 12 weeks) or mature (composted for 20 weeks with addition of 500 g/m^3 N) CGW to constitute 30% of the mix. Two peat types were included. One was a young undecomposed peat, H2 on the von Post scale and the second was more decomposed with a van Post rating of H5. An estimate of growing medium height was made two weeks after the start of the experiment to allow for initial settling and subsequent height measurements were made at four monthly intervals, except for one period from November 2000 to May 2001.

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 the addition of 500 g N as urea. After a further 2-month curing period, the compost was substituted for peat in a growing medium at 0, 25, 50 and 100% rates. 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 nutrient solution. Plant fresh weight was recorded at harvest.

RESULTS AND DISCUSSION

Generally the addition of CGW resulted in an increase in pH and EC (Table 1). The increase in EC was probably due to higher K levels. There was a decrease of P as a result of application of CGW. In some cases there was a reduction in N level and in others there was there was no effect. Depending on the feedstock of CGW, and the process, there could be N immobilization or mineralization. No measurements of micronutrients was made in this experiment but de Kreij and van der Gaag (2003) fount that CGW also contributes micronutrients and that therefore some adjustment of micronutrients addition may be desirable.

***Table 1**. Nutrient levels in CGW/peat mixes with three sources of CGW.*

Source	% CGW	pH	EC	P	K	NH_4-N	NO_3-N
Dublin	0	4.8	161	112	165	56	67
	20	5.8	204	94	280	60	74
	50	6.4	178	48	340	30	51
Thorpe	0	4.9	190	125	200	55	70
	20	5.5	177	88	300	41	59
	50	6.7	199	37	460	31	64
Dunbrik	0	5.0	197	120	230	58	70
	20	5.9	232	75	420	45	85
	50	6.6	289	34	680	32	97

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. This agrees with the findings of Scharpf (1997) and Verhagen (1997) in peat.

Table 2. *Effect of addition of CGW on the physical properties of growing media.*

% CGW	BD (g/L)	Pore space (%)	Air content (10 cm)	EAW [1]
0	116.3	93.6	23.2	25.9
10	140.0	91.5	24.3	25.5
20	168.1	90.3	23.3	24.7
50	240.5	87.4	24.0	19.0
F-test	***	***	NS	**
s.e	2.87	0.34	1.74	1.19

1 available water: water content at 10 cm - water content at 50 cm tension

Total bacterial counts increased significantly as the amount of CGW was added to peat from 0%, 10%, 25% and 50%. (Fig 1). This trend was apparent at 1 and 57 day samplings. The addition of lime and fertiliser to peat tended to increase bacterial levels. At 7 days highest levels were found at 25% of CGW addition. Total fungal counts tended to increase with the addition of CGW. The increase in the microbial activity due to the addition of CGW to peat could be an advantage in reducing the susceptibility of plants to root disease due to competition (Hoitink and Fahy, 1986).

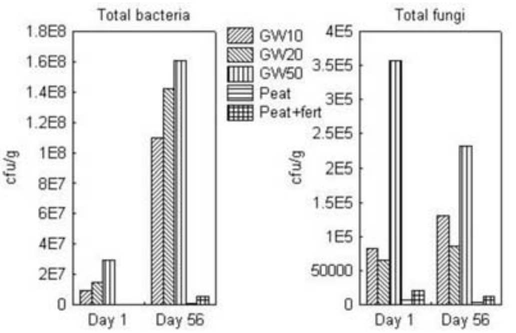

Figure 1*. Total bacteria and fungal counts in peat and CGW/peat mixes over 56 days.*

Table 3*. Effect of source and rate of CGW on the growth (g/plant) of tomato seedlings.*

Source	Rate of CGW (% volume)			Source	Rate of CGW (% volume)		
	10	20	50		10	20	50
Early harvest				Final harvest			
Dublin	13.2	13.4	9.9	Dublin	30.1	30.1	18.1
Thorpe	11.8	12.8	8.5	Thorpe	29.4	25.9	18.3
Dunbrik	13.7	11.1	5.9	Dunbrik	31.3	30.3	26.6
Mean	12.9	12.4	8.1		30.2	28.8	21.0
	Source	Rate	Interaction		Source	Rate	Interaction
F-test	***	***	*		***	***	***
s.e.	0.31	0.36	0.63		0.47	0.55	0.95
100% Peat control		12.2				27.0	

The results of the growth experiment are shown in Table 3. At the first harvest, there was no effect on the CGW on growth up to 20% levels. At the 50% rate, plants growing in the Dunbrik material were severely reduced in weight, while the Dunbrik and Thorpe were much less so. This is probably a result of the high K and EC levels in the Dunbrik material. At the final harvest growth was again little affected by the inclusion of CGW up to a proportion of 20% . At the 50% rate growth was severely reduced in the Dublin and Thorpe materials while the reduction was much less in the Dunbrik material. This is exactly the 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=-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.

During composting of the mixture of three wastes, temperature fell from an initial level of over 60 ^{o}C down to 30-35 ^{o}C over a 12 week period (Figure 3).

In the physical structure experiment, with H2 peat, there was an obvious effect of addition of young CGW on degradation from November 2000 onwards while treatments with mature CGW were never significantly different from 100% peat (Figure 2). In the case of H5 peat, adding young CGW resulted in a significant increase in degradation over 100% peat by November 2000 which was 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.

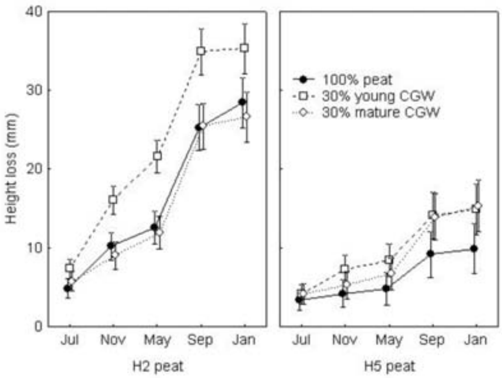

Figure 2. *The effect of addition of young and mature CGW to two types of peat on the physical degradation of the growing medium.*

In the growing trial (Table 4) 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. However plant appearance was perfectly 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.

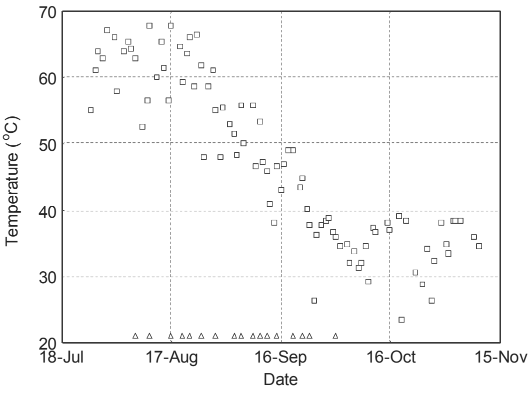

Figure 3. *Temperatures during composting of green waste, sawdust and spent black brewer's grain(triangle symbols mark turning dates).*

Table 4. *Effect of compost substitution for peat on the growth of tomato seedlings.*

Compost rate (% of vol.)	Fresh wt (g/plant)
0	36.6[a]
25	33.6[b]
50	33.5[b]
100	30.2[c]
F-test	***
s.e.	0.90

(values without a common suffix are significantly different from each other)