9 EFFECTIVENESS OF HOME PRODUCED COMPOSTS AS SOIL IMPROVERS FOR THE GROWTH OF *PETUNIA GRANDIFLORA* F_1H

9.1 INTRODUCTION

Peat is extensively used to condition horticultural soils and to enhance plant growth (RSNC, 1990) because it is a well-established, effective and relatively cheap product, requiring no processing. The price of peat is low because the environmental costs associated with its extraction and use are currently not reflected in its price. However, peat is a finite resource and there is increasing concern over the environmental damage caused by large-scale peat extraction (DETR, 1999e). Total horticultural peat consumption in the UK is estimated at 3.4 x 10^6 m^3 per year, the majority of which (96 %) is used in growing media formulation (DETR/WO, 1999d).

Peat is a limited resource with a very long production time. Peat bogs are important refuges for rare and unique species and peat has a fundamental ecological role in water retention. Peat bogs play an important role in storing carbon that is released as CO_2 when a peat bog is damaged. Although peatlands cover around half the surface area covered by tropical rainforests, they contain over three to three and a half times more carbon (Maltby *et al*., 1992).

Experimental work published including studies by Smith (1992), Ribeiro *et al*. (1999) and Hicklenton *et al*. (2001) demonstrated the suitability of composted biowastes, including MSW as substitutes for peat as soil improving materials for use in horticulture. Considerable progress has occurred in replacing peat for general application to soil with alternative, predominately biowaste derived materials. Current statistics (DEFRA, 2000) suggests that 95 % of the market for general soil conditioners is satisfied by peat alternatives. Whilst environmental arguments for promoting HC on the basis of peat replacement have largely been dealt with, peat is still used by home gardeners, and there is an incentive to homeowners to compost to save the cost of purchasing soil conditioning products, which are often sold at a premium through retail outlets. The effects of composted residues for small-scale compost bins as soil improvers for plant growth have not been previously quantitatively assessed. A demonstratable benefit of home composts at increasing garden productivity would enhance homeowner satisfaction and would be a further incentive for them to continue composting domestic biodegradable waste.

The purpose of this study was, therefore, to assess the end-use of composted product from selected experimental compost management treatments from the Study Trial as soil conditioners for the growth of *Petunia grandiflora* F_1H. This test plant provides a suitable indicator and effective species for assessing the quality of compost for plant growth based on flower number production (Smith, 1992) in comparison to peat.

9.2 MATERIALS AND METHODS

The field trial was established at the Imperial College Field Station at Silwood Park, Ascot (grid ref: 944 686) on a impoverished sandy loam soil. Soil at Silwood Park is light-textured and susceptible to drought stress and is suitable for assessing the effects of compost application on the moisture retention properties of soil. Furthermore, it has a low nutrient status and can provide useful information on the fertiliser value of organic manures and composts (Table 9.1).

Table 9.1 Selected physico-chemical properties of soil at Silwood Park (Triner, 1999)

Parameter	Loamy sand
Sand (%)	82
Silt (%)	12
Clay (%)	6
pH	6.2
NO_3-N content (mg kg^{-1} dry soil)	31.3
Available P (mg l^{-1})	30.6
Available K (mg l^{-1})	129
Available Mg (mg l^{-1})	82
Exch. Ca (me 100 g^{-1})	5
CEC (me 100 g^{-1})	7.9
Organic matter (%)	3.8

Composted materials were collected from replicate bins of selected management treatments between 16th April and 25th May 2001. The collected material was from Layer C sampled from the home compost bins (Section 3). Composts and peat were applied on 1st June 2001 to experimental plots with dimensions of 1.5 x 1.5 m (2.25 m^2) by hand at a rate equivalent to 2 kg m^{-2} (dry matter) (DETR, 1999f) and were incorporated into the soil to a depth of 10 cm using a pedestrian operated rotary cultivator. A total of 12 treatment plots were arranged in three randomised blocks.

Materials evaluated in the field trial included factorial combinations of: garden size (large and small), +/- worm inoculum and +/- accelerator (treatment structure: 2x2x2 = 8). Two further unbalanced compost treatments included materials from bins processing waste from small gardens, to test the effects of mixing on compost quality (without worm inoculum or accelerator). The experimental treatments are listed in Table 9.2. A control plot received a standard peat dressing and a second control was maintained in an untreated condition (Table 9.2).

Plant material was raised for the experimental work by arrangement with Swallowfield Road Nurseries, Arborfield, Reading using recommended production techniques and conditions. Briefly, seed of *Petunia grandiflora* F_1H was sown into 300 plugs containing a standard peat-based compost (Bulrush, Ireland) during March 2001. They were transplanted after 6 weeks into 10 cm pots containing peat-based compost and maintained in a heated glasshouse set to give a minimum temperature of 14 ºC and were base irrigated with mains water by capillary matting. Slow-release fertiliser formulations were excluded from the growing media. Potted petunias were placed in a frost-free polytunnel in May 2001 at ambient temperature till transplanted in the field.

Twenty five pot-raised petunias were transplanted into each experimental plot on 1st June 2001 at a spacing of 30 cm. All plots were irrigated twice a week. Flowers (Plate 9.1) were counted and removed on a weekly basis during the monitoring period commencing on 7th June 2001 and the final count was taken on 28th August 2001. Plant material was harvested on 30th August 2001 and dried in a forced-air oven at 80 ºC for 48h for dry weight determination. Dried plant material from each experimental plot was ground with a laboratory mill and bulked together to provide representative material for chemical analysis (see Section 3.5). Soil samples were collected on 9th December 2001 by pooling 5 cores taken to a depth of 10 cm for each replicate plot. These were air-dried and ground with a pestle and mortar to pass a 2 mm sieve for chemical analysis (see Section 3.5).

Table 9.2 Key to compost treatments

Code	Abbreviation	Compost treatment
A	Small	Small Garden compost (untreated control)
B	Small (Mix)	Small Garden compost (mixed)
C	Small (Acc)	Small Garden compost (accelerator addition)
D	Small (In+Acc)	Small Garden compost (accelerator and earthworm addition)
E	Small (In)	Small Garden compost (accelerator and earthworm addition)
F	Large	Large Garden compost (untreated control)
G	Large (Mix)	Large Garden compost (mixed)
H	Large (Acc)	Large Garden compost (accelerator addition)
I	Large (In)	Large Garden compost (earthworm addition)
J	Large (In+Acc)	Large Garden compost (accelerator and earthworm addition)
K	Peat	Peat
L	Control	Control (Unamended)

Plate 9.1 Flower production by petunias amended with home composted and peat materials

9.3 RESULTS AND DISCUSSION

9.3.1 Chemical characteristics of home compost and peat

The nutrient properties of the compost materials used in the field trial are listed in Table 9.3. As would be expected, concentrations of plant nutrients in peat were small with the exception of NO_3–N and NH_4-N, which were in larger concentrations in comparison to the composted materials (Table 9.3). Generally, composted residues from the large garden size group contained the largest amounts of total N, P and K overall (Table 9.3), suggesting that inputs of green waste, which is characteristic associated with this management treatment, could be responsible for increasing concentrations of these particular nutrients. Home composts treated with accelerator and earthworm inoculum, from both large and small garden size groups, contained similar amounts of total N, P and K.

9.3.2 Chemical properties of amended soil

Chemical properties of soil samples collected from the experimental plots are summarised in Table 9.4. Concentrations of nutrients ranged from 0.34 - 0.93 % dm for total N, 0.09 - 0.26% dm for total P, 39.6 - 363.1 mg kg^{-1} dm for total Mg and 0.03 - 0.07 % dm for total K. The highest concentrations were measured in soil receiving compost from the large garden size group with accelerator addition, and the smallest nutrient concentrations were in soil amended with peat.

Concentrations of total N, P, K and Mg in soil samples increased linearly in relation to the rate of these nutrient inputs to the soil in the composted residues and peat (Figure 9.1). Thus, nutrient addition to the soil was a function of compost nutrient content since equivalent rates of dry matter were supplied (2 kg m^{-2}) to the amended plots in the field experiment.

9.3.3 Plant growth performance

The effects of compost addition on plant growth performance were assessed using a flower counting technique (Figure 9.2). Cumulative flower production of petunias (mean per plant) increased with time during the experimental period (Figure 9.2; Table 9.5). The total cumulative flower production of petunias and plant dry weight data are presented in Figure 9.3 and show that flower production increased as a simple linear function of increasing plant dry weight. Therefore, flower production by petunias provided a basis for the non-destructive measurement of plant growth performance in soils supplied with home produced compost.

Addition of home compost to the soil significantly increased flower production by petunias compared with the unamended soil (control). By contrast, flower production was significantly reduced by peat incorporation compared to the control. The results showed that all plots receiving home produced composts gave larger flower numbers than either peat-amended soil or the untreated control treatment. Therefore, home composts provide an effective alternative to peat for general soil conditioning purposes. Petunias amended with compost from the large garden size treatments generally produced the most flowers compared to the other composting management methods. There were no other consistent trends apparent between composting management technique and plant growth performance. Compost treatments in order of flower production performance were ranked as H>F> E>B>D>I>G>C>A>J>L>K (see Table 9.2).

Table 9.3 Chemical Properties of home composts and peat supplied in the field trial, April 2000-May 2001

Compost treatment	Dry solids (% FW)	Total N (% dm)	Total P (% dm)	Total K (% dm)	Total Mg (mg kg^{-1} dm)	NH_4-N (mg kg^{-1} dm)	NO_2-N (mg kg^{-1} dm)	NO_3-N (mg kg^{-1} dm)	Extract P (% dm)
Large	24.5	4.0	0.16	1.7	337.9	16.0	2.0	33.5	0.66
Large (Acc)	29.9	3.2	0.18	2.0	334.7	14.3	2.2	31.4	0.61
Large (Acc+In)	20.9	3.9	0.12	1.8	337.9	18.8	0.7	40.7	0.60
Large (In)	24.5	3.6	0.11	2.1	333.7	16.7	1.6	34.9	0.45
Large (Mix)	32.0	2.4	0.14	1.2	264.5	14.0	0.3	26.0	0.44
Small	31.7	2.9	0.06	1.8	363.1	11.6	0.8	26.6	0.18
Small (Acc)	46.1	2.0	0.12	2.8	221.3	8.5	0.4	17.0	0.27
Small (Acc+In)	28.1	3.4	0.11	1.8	449.7	16.9	3.2	33.7	0.39
Small (In)	44.5	1.9	0.10	1.7	220.5	9.9	0.6	12.2	0.22
Small (Mix)	36.4	2.1	0.17	0.8	305.8	10.8	0.4	24.9	0.46
Peat	30.4	0.2	0.02	0.1	107.2	57.5	0.3	66.2	0.05

Table 9.4 Chemical properties of field soil amended with different home composts and peat, sampled at the end of the field experiment, August 2001

Treatment	Total N (% dm)	Total P (% dm)	Total Mg (mg kg^{-1} dm)	Total K (% dm)	pH
Large control	0.72	0.21	320.0	0.07	6.57
Large accelerator	0.93	0.26	363.1	0.08	6.74
Large accelerator/inoculum	0.44	0.13	105.7	0.04	5.67
Large inoculum	0.54	0.16	190.3	0.05	6.13
Large mix	0.51	0.15	169.9	0.05	6.06
Small control	0.44	0.14	128.3	0.04	5.78
Small accelerator	0.47	0.15	146.4	0.05	5.97
Small accelerator/inoculum	0.58	0.18	221.9	0.06	6.20
Small inoculum	0.67	0.19	286.5	0.06	6.32
Small mix	0.63	0.18	252.4	0.06	6.24
Control (unamended plot)	0.41	0.11	60.0	0.04	4.45
Peat	0.34	0.09	39.6	0.03	2.13

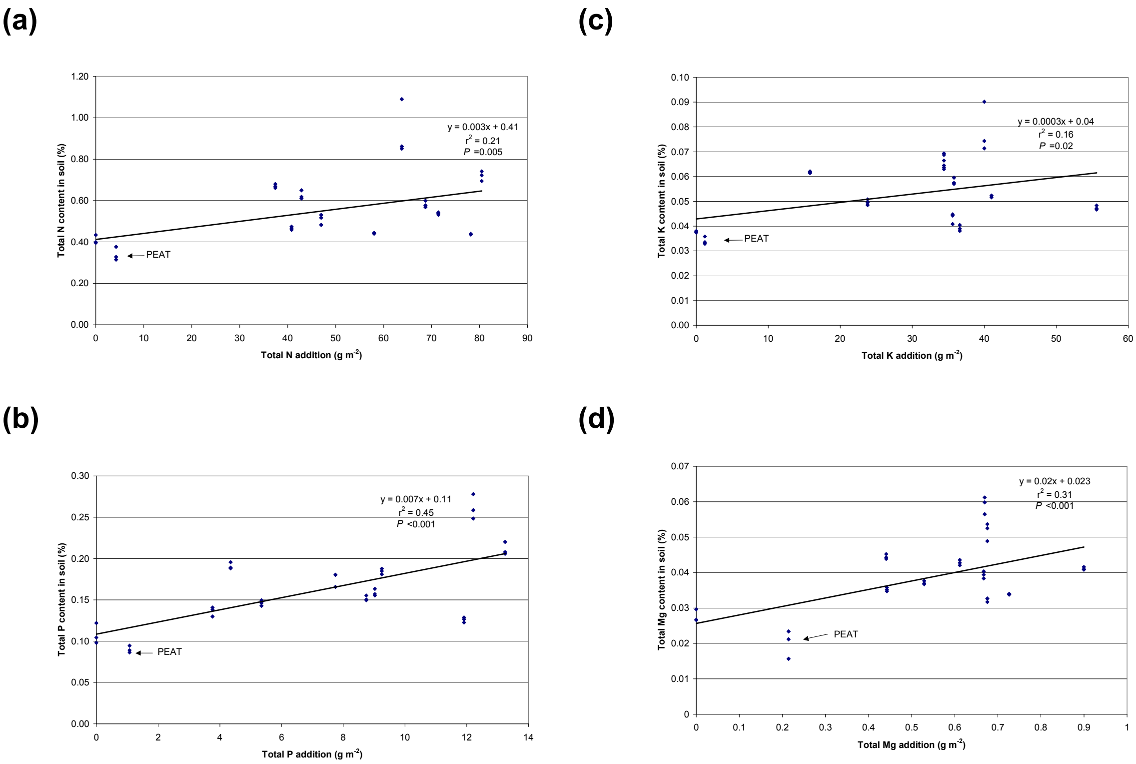

Figure 9.1 Effect of nutrient inputs to soil in home composts and peat on the total nutrient concentrations in field soil

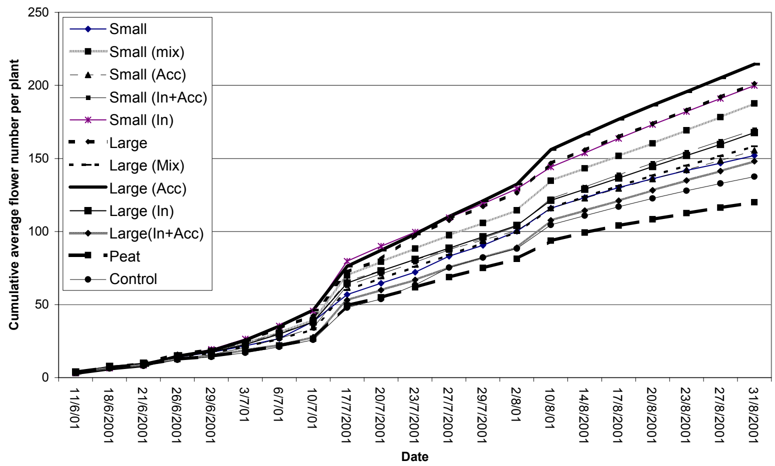

Figure 9.2 Cumulative flower production by P. grandiflora F_1H in soil amended with different home produced composts or peat

Table 9.5 **Cumulative flower production of *P. grandiflora* F_1H (mean per plant) planted in a sandy loam soil treated with 12 different home composts**

Harvest date	A	B	C	D	E	F	G	H	I	J	K	L	LSD
11/6/01	33.3	28.0	30.3	27.7	29.3	31.0	28.0	26.7	34.7	31.3	34.7	31.0	8.34
18/6/01	62.3	58.7	63.0	56.7	58.3	60.0	57.3	53.3	68.7	59.0	63.3	56.0	7.62
21/6/01	83.7	79.7	82.0	74.0	76.0	88.3	76.0	73.7	88.7	75.7	80.0	71.7	6.21
26/6/01	126.0	135.3	137.0	116.7	133.7	144.7	127.0	132.0	132.7	114.7	114.7	109.7	17.4
29/6/01	155.0	166.7	163.3	142.0	173.7	170.7	151.0	165.3	158.3	132.3	132.3	128.0	9.91
3/7/01	195.7	211.0	213.0	185.7	237.7	228.3	191.7	230.3	204.0	169.0	161.3	152.7	19.7
6/7/01	241.0	276.7	273.0	241.0	317.7	304.7	236.7	316.7	268.3	200.3	197.0	189.0	19.7
10/7/01	345.3	354.7	340.7	307.7	410.0	381.0	295.7	414.7	343.7	248.0	238.7	233.0	22.5
17/7/01	511.7	630.0	594.3	568.0	717.0	650.0	539.0	685.7	582.3	477.7	444.0	430.7	46.0
20/7/01	581.0	713.0	660.3	638.7	809.7	729.3	611.0	785.0	656.7	538.3	494.7	483.0	21.5
23/7/01	650.0	795.0	725.0	711.0	897.0	878.0	682.0	884.0	728.0	602.0	556.0	570.0	52.4
27/7/01	747.0	876.0	788.0	788.0	986.0	969.0	755.0	992.0	798.0	678.0	620.0	678.0	35.3
29/7/01	815.0	953.0	847.0	860.0	1072.0	1054.0	827.0	1089.0	868.0	739.0	676.0	739.0	16.1
2/8/01	910.0	1030.0	906.0	932.0	1163.0	1138.0	894.0	1192.0	937.0	800.0	732.0	795.0	16.2
10/8/01	1044.0	1213.0	1044.0	1103.0	1297.0	1321.0	1046.0	1405.0	1092.0	968.0	844.0	941.0	50.0
14/8/01	1109.0	1289.0	1105.0	1175.0	1384.0	1402.0	1114.0	1499.0	1160.0	1029.0	894.0	998.0	12.4
17/8/01	1171.0	1365.0	1165.0	1250.0	1473.0	1484.0	1180.0	1591.0	1229.0	1090.0	937.0	1053.0	13.8
20/8/01	1225.0	1443.0	1223.0	1321.0	1558.0	1564.0	1245.0	1678.0	1299.0	1153.0	976.0	1103.0	14.8
23/8/01	1276.0	1523.0	1281.0	1389.0	1639.0	1647.0	1306.0	1761.0	1369.0	1214.0	1013.0	1152.0	18.7
27/8/01	1321.0	165.0	1338.0	1457.0	1719.0	1729.0	1365.0	1846.0	1436.0	1273.0	1047.0	1196.0	21.7
31/8/01	1368.0	1689.0	1399.0	1527.0	1800.0	1811.0	1424.0	1931.0	1508.0	1332.0	1081.0	1239.0	24.0

LSD, least significant difference at P=0.05

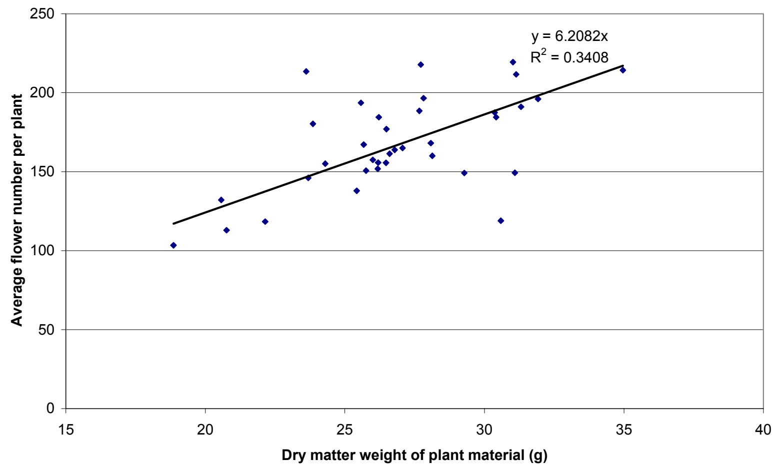

Figure 9.3 Relationship between cumulative flower production and dry matter yield of *P. grandiflora* F_1H

9.3.4 Plant nutrient status

Examination of the relationships between nutrient inputs to soil from home composts and peat showed that flower productivity increased significantly in linear relation to the total amounts of nutrients applied to soil in compost (Figure 9.4). Further evidence indicating that nutrient supply in compost, rather than specific composting management factors, primarily determine flower production was provided by the significant positive relationships detected between the nutrient concentrations in soil and cumulative flower production (Figure 9.5). The concentrations of major nutrients in plant material are shown in Table 9.6, which also gives the optimal tissue concentrations of N, P and K for growth of petunias (Dight, 1977). The results indicated the supply of N and K was sub-optimal generally, but adequate amounts of P were provided by compost in some cases. Nevertheless, the plant tissue content was increased in all experimental treatments amended with compost, compared with peat and the untreated control. Indeed, the nutrient concentrations in plant tissues were smaller for peat compared with any other treatment, including the control. Overall, the relatively small concentrations of N and K, which are relatively labile elements in plant tissues, may be explained because the plant material was mature at the time of harvest. The positive influence of nutrient inputs in compost on plant tissue concentrations and the associated increase in flower productivity is shown in Figures 9.6 and 9.7, respectively.

9.4 SUMMARY

Results from this investigation compare closely to experimental work demonstrating the suitability of MSW derived composts as substitutes for peat as soil improving materials for use in horticulture (Smith, 1992; Ribeiro *et al*., 1999; Hicklenton *et al*., 2001). Home composted products were superior to peat as soil improvers and increased the growth response of petunias in a low fertility sandy soil. All plots receiving home produced composts gave larger flower numbers than either peat-amended soil or the untreated control. The results showed that, in general, increased plant performance was associated with the nutrient concentrations and supply in compost rather than any specific composting management factor. Material from the large garden size group consistently contained more nutrients and, consequently, also gave the best overall plant performance response.

This field investigation has demonstrated the effectiveness of home produced composted materials at improving plant growth performance and as potential replacements of peat-based substrates for general horticultural use as soil improvers. Therefore, home compost has significant potential for use as a soil conditioner and can effectively replace peat for this purpose.

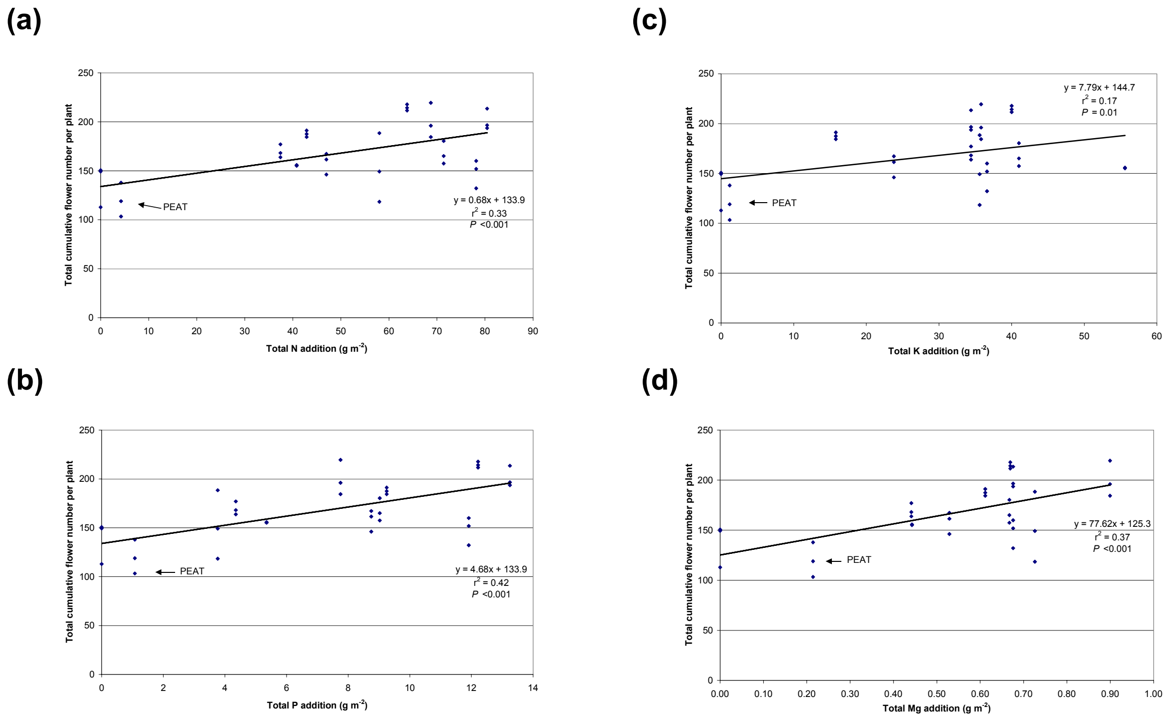

Figure 9.4 **Total cumulative flower production per plant in relation to inputs of (a) N, (b) P, (c) K, (d) Mg in home composts and peat**

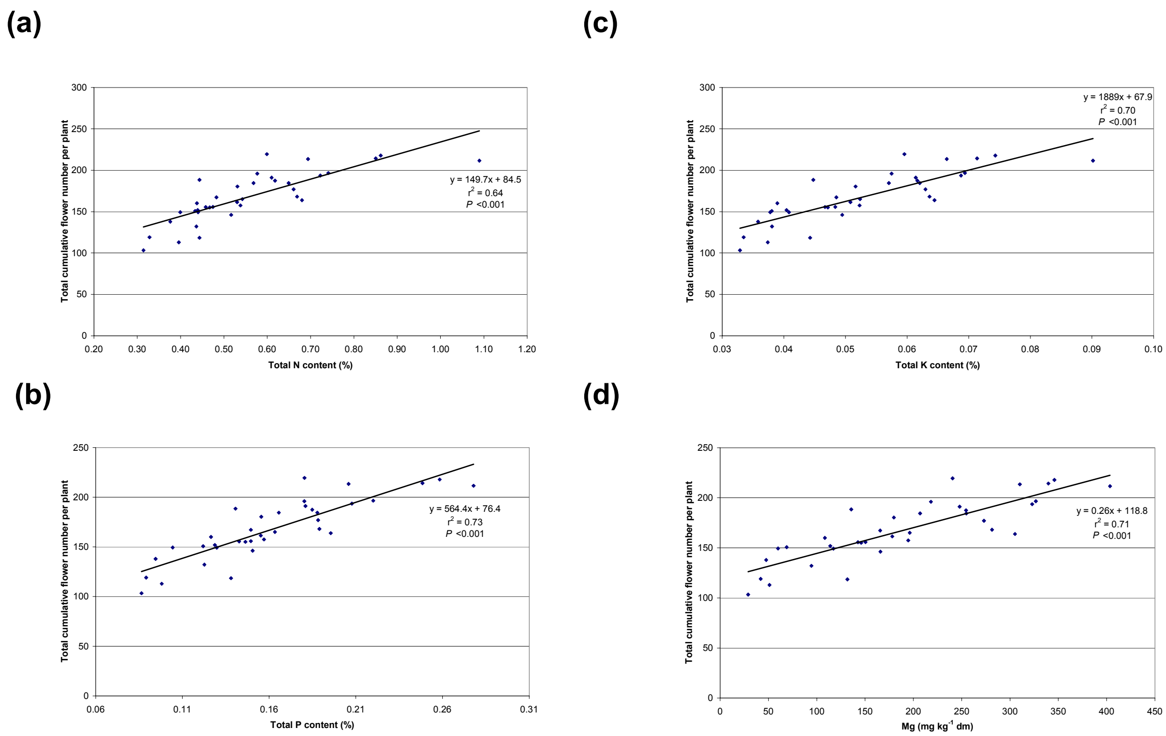

Figure 9.5 **Plant tissue concentrations of (a) N, (b) P, (c) K, (d) Mg in relation to soil nutrients**

Table 9.6 Concentrations of major nutrients in tissues of *P. grandiflora* F_1H

Treatment	Total N (% dm)	Total P (% dm)	Total Mg (mg/kg^{-1} d.s)	Total K (% dm)
Large	1.80	0.34	516.7	2.47
Large (Acc)	1.90	0.36	591.7	2.68
Large (Acc+In)	1.22	0.23	323.5	1.88
Large (In)	1.53	0.30	393.7	2.19
Large (Mix)	1.50	0.28	371.2	2.15
Small	1.38	0.25	338.9	2.00
Small (Acc)	1.46	0.27	352.1	2.10
Small (Acc+In)	1.59	0.31	411.2	2.26
Small (In)	1.68	0.33	444.5	2.36
Small (mix)	1.63	0.32	427.8	2.32
Control (unamended plot)	1.15	0.20	276.4	1.80
Peat	1.09	0.17	200.6	1.43
Petunia multiflora F_1 hybrid (Purple Defiance) (Dight, 1977)	4.32	0.37	N/A	4.16

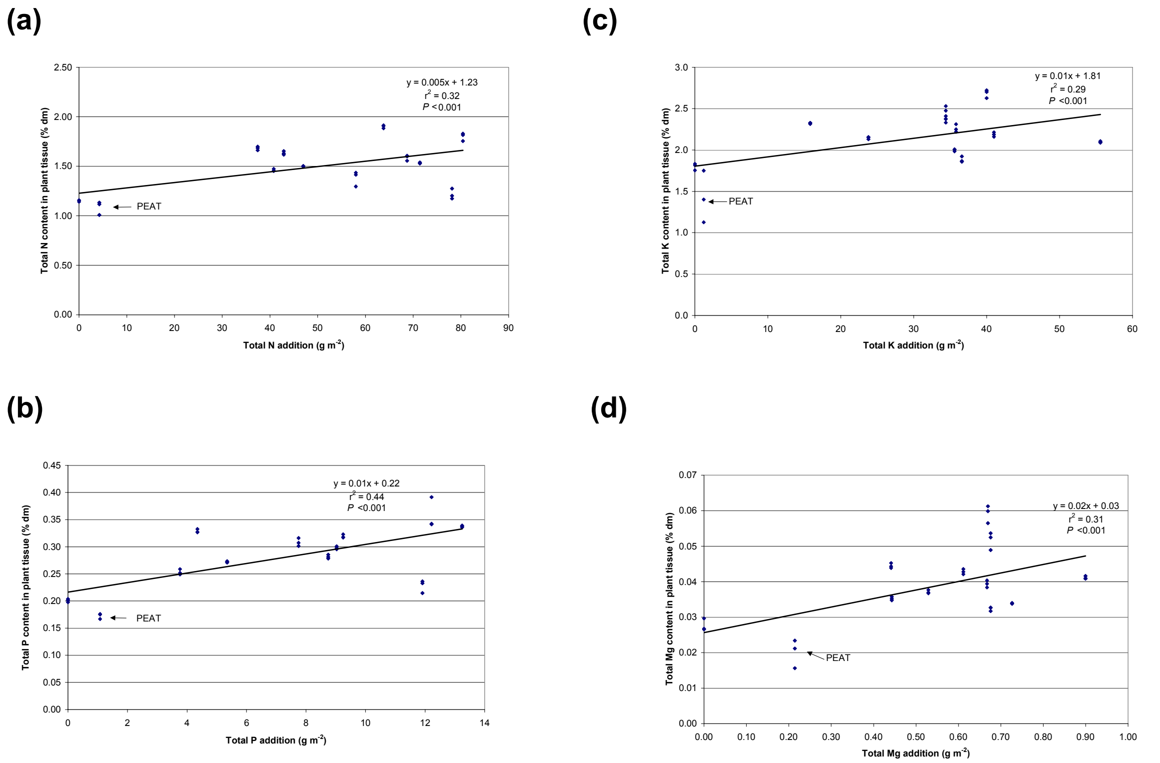

Figure 9.6 Plant tissue contents in relation to inputs of (a) N, (b) P, (c) K, (d) Mg in home composts and peat

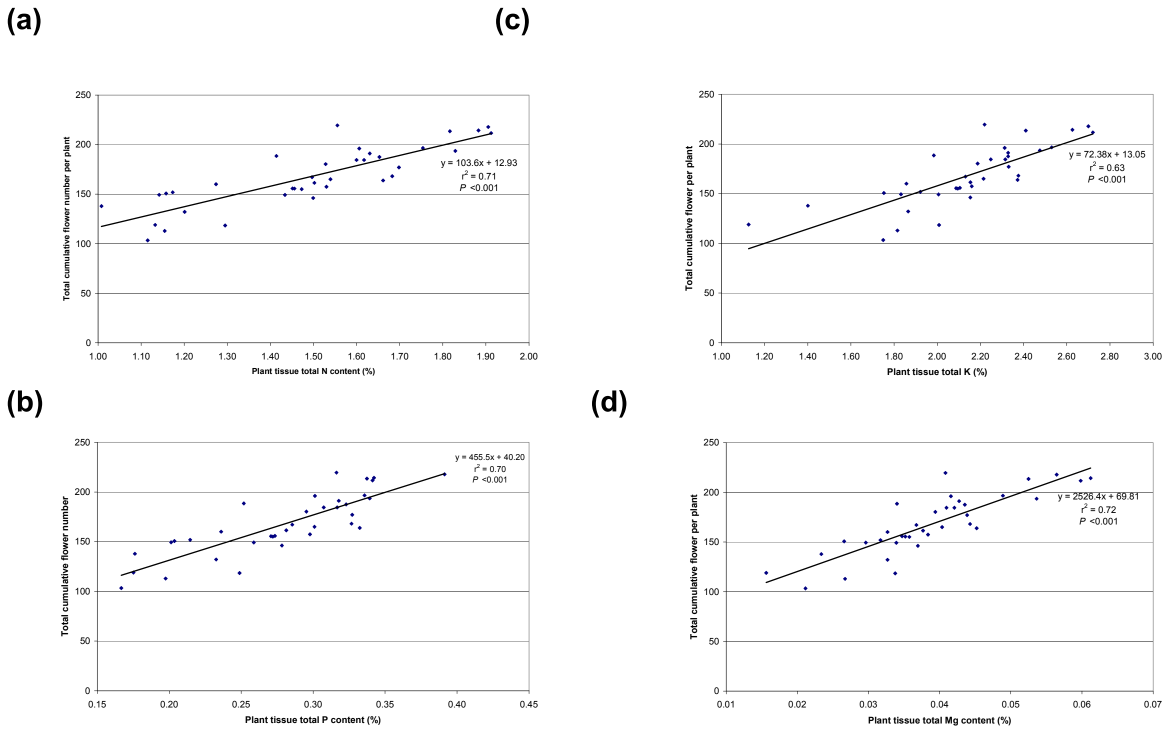

Figure 9.7 Total cumulative flower production per plant in relation to concentrations of (a) N, (b) P, (c) K, (d) Mg in plant tissues of petunia