

LEVINGTON AGRICULTURE

REPORT

by S M Boon

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Report on LA Project 99164

Field Trials on

Compost

For: Enventure Research

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ABBREVIATIONS

cm	centimetre
CV%	Co-efficient of Variation
DM	dry matter
g	gram
GM	General Mean
ha	hectare
K, K ₂ O	potassium, potash
kg	kilogram
l	litre
LA	Levington Agriculture Ltd
LSD	Least Significant Difference
Mg	magnesium
mg	milligram
mm	millimetre
Mn	manganese
N	nitrogen
NS	Not Significant
P, P ₂ O ₅	phosphorus, phosphate
S	sulphur
SE	Standard Error
t	tonnes
yr	year
+	(P=0.10) significant at 0.10 probability level
*	(P=0.05) significant at 0.05 probability level
**	(P=0.01) significant at 0.01 probability level

SUMMARY

Composted green waste was applied as a partial substitute for inorganic fertilizer for potatoes and sugarbeet growing on a sandy soil. As expected, the availability of the N and P in the compost was small in the first year after application. Potassium was more readily available. It is likely that compost could successfully form part of the rotational fertilizer policy for arable crops.

This project has been funded using landfill tax credits generated by Suffolk Waste Disposal Company and managed by Enventure Ltd.

OBJECTIVE

To assess the effects of adding composted green waste to land by growing potatoes and sugarbeet and to carry out a market evaluation of the compost in agriculture.

METHODSTreatments

1. Untreated control
2. Base inorganic fertilizer + N top dressing
3. 50 t/ha compost + base inorganic fertilizer + N top dressing
4. 100 t/ha compost + base inorganic fertilizer + N top dressing
5. 50 t/ha compost
6. 100 t/ha compost
7. 50 t/ha compost + N top dressing
8. 100 t/ha compost + N top dressing

Rates of inorganic fertilisers kg/ha

	<u>Potatoes</u>	<u>Sugarbeet</u>
Base inorganic fertilizer	110 kg N 200 kg P ₂ O ₅ 250 kg K ₂ O	50 kg N no phosphate 100 kg K ₂ O 150 kg Na (400 kg salt)
N top dressing	110 kg N/ha	50 kg N/ha
Timing of top dressing	tuber initiation	2 true leaf

Based on the compost analysis results in Table 4 the addition of the compost gave the equivalent nutrient addition as follows:

<u>50 t/ha</u>	<u>100 t/ha</u>
260 kg N	520 kg N
220 kg P ₂ O ₅	440 kg P ₂ O ₅
393 kg K ₂ O	786 kg K ₂ O
74 kg S	148 kg S

The Code of Good Agricultural Practice for the Protection of Water recommends a limit of 250 kg N/ha/yr for organic materials applied to land unless, as in this case, the material is relatively inert, when the limit is 500 kg N/ha/yr. Less than 10% of the total nitrogen in the compost used was extractable in water (1:6 ratio). The trials were sited in Suffolk, and were cropped with potatoes and sugarbeet (see Table 1 for trial diaries). Previous cropping of each site is shown in Table 2. Soil analysis was carried out at each site pre-treatment (see Table 3) and post harvest. The rates of compost were determined with respect to the analysis (see Table 4). Emergence counts were taken, and the colour and vigour of the crops were assessed monthly. Crop samples were taken for analysis at full canopy and at harvest, and

yields were recorded at harvest. The potatoes were assessed for internal and external diseases. The trials, with four replicates of each treatment, were of randomised block design and were statistically analysed accordingly. Full details are shown in the attached Project Plan.

Table 1 Trial Diaries991640 – potatoes

1.2.99	Site claimed. Outline marked. Soil sample taken
24.2.99	Fully marked out. Base fertilizer applied. Pegged back to hedgerow
11.3.99	Compost spread
28.3.99	Site planted
26.4.99	Site reclaimed and outline marked
24.5.99	Site fully marked out after planting. Tuber initiation treatments applied. No visual differences
26.5.99	Emergence count
4.6.99	Site visited. No colour or vigour differences
17.6.99	Colour and vigour assessment
29.6.99	ADAS visited
15.7.99	Full canopy leaf samples taken
19.7.99	Colour and vigour assessment
16.9.99	Plots 1-24 lifted
17.9.99	Plots 25-32 lifted. Soil samples taken from each plot
21.9.99	Samples assessed for skin finish and black leg. Samples put in for analysis
24.9.99	Samples assessed for internal diseases

991641 - sugarbeet

1.2.99	Site claimed. Outline marked. Soil sample taken
24.2.99	Site fully marked out and base fertilizer applied. Pegged to track
11.3.99	Compost applied and spread. Pegs removed ready to plough
16.4.99	Site drilled
26.4.99	Site reclaimed
7.5.99	Site re-drilled due to poor germination
24.5.99	Site fully marked out. Top dressing 2 true leaf stage applied
4.6.99	Emergence count done. No colour or vigour differences
17.6.99	Colour and vigour assessment
29.6.99	ADAS visited
19.7.99	Colour and vigour assessment
19.8.99	Vigour assessment. No visible colour differences
27.9.99	Colour and vigour assessment
29.9.99	Plots harvested and sent for assessment
13.10.99	Sub samples taken for analysis

Table 2 Previous cropping of sites

	Potatoes	Sugarbeet
Last year	Sugarbeet	Winter barley
2 years ago	Winter barley	Potatoes
3 years ago	Winter barley	Winter barley
4 years ago	Linseed	Winter barley

Table 3 Soil analysis

	Potatoes	Sugarbeet
Soil texture	Sandy loam	Sandy loam
Clay %	13	13
Silt %	8	10
Sand %	79	77
pH	7.6	7.2
P mg/l (index)	80 (3)	90 (4)
K mg/l (index)	136 (2)	103 (1)
Mg mg/l (index)	51 (2)	61 (2)
S mg/kg	5.0 (low)	5.0 (low)
Organic matter %	1.03	0.86

Table 4 Compost analysis

Bulk density	g/l	608
Moisture	% by weight	35.7
pH		7.9
Conductivity	µS/cm	1340
Organic carbon	%DM	10.8
C:N ratio		13.3
Organic matter	%DM	34.2
Neutralising value	%CaO in DM	4.76
Water extractables		
NH ₄ -N	mg/l	<3.0
NO ₃ -N	mg/l	246.0
P	mg/l	150.0
K	mg/l	1950
Mg	mg/l	22.2
Cu	mg/l	0.18
Zn	mg/l	0.24
Mn	mg/l	<0.12
Fe	mg/l	5.22
Total		
N	%DM	0.81
P	%DM	0.30
K	%DM	1.01
S	%DM	0.23
Particle size		
>20mm	% retained	0
10-20mm	% retained	0.53
5-10mm	% retained	7.74
1-5mm	% retained	49.76
Passing 1mm	% retained	41.97

RESULTS For full statistical analysis of results, see Appendices (treatment means appended by the same letter are not significantly different by Duncan's Multiple Range Test).

991640 - potatoes

The compost was applied pre-planting and ploughed in, and the potatoes were top dressed with inorganic nitrogen as required in May at tuber initiation. Effects were seen from the treatments from June onwards. The untreated plants were poorest in colour and vigour at all times, with good responses seen from the standard farm practice fertilizers (appendix 1.1). The addition of 50 t/ha compost to these fertilizers improved responses above farm practice, although 100 t/ha did not.

Compost alone gave small responses in colour and vigour, more so from 100 t/ha than 50 t/ha. The addition of nitrogen top dressing resulted in good responses from 50 t/ha, similar to farm practice, but 100 t/ha compost plus top dressing seemed to be excessive. Plant emergence was not affected by fertilizer or compost treatment.

Foliage analysis (appendix 1.2)

Leaf analysis in July showed that the site was responsive to nitrogen but that this green waste compost on its own could not be considered as a large, immediately available nitrogen source, although its nitrogen might be released over a longer time span. Potassium levels in the leaves were increased by the standard base fertilizers, and even more so by the compost, reflecting its high K content. Leaf magnesium was reduced where compost alone was applied but this may be an interaction with potassium and a less vigorous root system. Sulphur and manganese levels were adequate in the plants.

Crop yield (appendix 1.3)

Potato tuber yields were high at this site at 55 t/ha for the standard farm practice compared with only 30 t/ha without fertilizer. Addition of compost to standard fertilizer at both 50 and 100 t/ha did not affect yield up or down. Compost alone increased yields by only 7 t/ha; however, with a top dressing of N, yields were 46 and 47 t/ha for 50 and 100 t compost/ha, respectively. All of these yield effects were almost entirely found in the important 60 to 80 mm size fraction of the tubers. It is likely that compost could replace all of the base dressing apart from some of the nitrogen and some phosphate.

Residual N (appendix 1.6)

Analysis of the soil after harvest showed that there was no excessive mineral nitrogen remaining in the soil from the compost or other treatments that might lead to significant nitrate leaching compared with the untreated plots.

Crop quality (appendices 1.4, 1.5, 1.7-9)

The potatoes were assessed for diseases at the end of the trial. Some blackleg had been seen in the field and this was confirmed at these assessments. Although not statistically significant, the untreated had the greatest percentage of tubers with blackleg and compost tended to reduce levels where adequate nitrogen had been given to give good crop vigour. The overall average percentage of tuber infected with blackleg was less than 0.5%. These effects would need further investigation to be verified. Other diseases were also recorded but were of minor importance and had little effect on quality. Even with almost 50% of the tubers having some vascular browning, the average browning in the tubers was less than 1%, but there was again a slight indication that the compost was having a beneficial effect.

No major effects on moisture content of the tubers were seen, nor effects on bruising. Analysis of the tubers for nutrient content confirmed that the compost was not providing enough nitrogen on its own to raise the N content above that of the untreated, and that some basal N would also be needed. There were no significant effects on sulphur, phosphorus, magnesium and calcium contents from compost addition. Potassium content however was significantly raised by the addition of compost at 100 t/ha.

The nutrient removal by the tubers has also been calculated, and shows high usage of N and K.

991641 - sugarbeet

The compost was applied in March and the plots drilled in April. However, due to heavy rainfall and capping, germination was poor and the site had to be re-drilled in May. There were no significant effects on plant emergence due to treatments seen in June.

Differences between treatments were seen after the top dressings of nitrogen at the end of May. The untreated beet was poorest in colour and vigour (appendices 2.1 and 2.2). The standard farm inorganic fertilizer programme gave good responses which were enhanced, to a small degree, especially by the addition of the high rate of compost (100 t/ha).

Compost alone at 50 t/ha did not give good responses but at 100 t/ha the colour and vigour of the beet were similar to farm practice. The addition of nitrogen top dressings improved the plants where only 50 t/ha compost had been applied, but not greatly where 100 t/ha had been spread.

Foliage analysis (appendix 2.3)

Leaf N levels in the sugarbeet crop increased above untreated where compost was applied, and more so with the topdressing of N and the base fertilizer. Other nutrients were found to be in adequate supply.

Crop yield (appendix 2.5)

Beet yield at standard farm practice was 71 t/ha and beet sugar yield was 12 t/ha. The addition of the compost at both rates to the standard fertilizer applications did not affect the yields significantly, although they were 4 tonnes higher with 100 t/ha compost and sugar yield up by over half a tonne/ha. Yields on plots where compost was applied at 100 t/ha with no inorganic addition were as high as the farm standard. The two rates of compost applied with top dressing increased yields significantly over the untreated control. The compost applied at 50 t/ha with no inorganic addition did not increase yields over the untreated control.

Crop quality (appendices 2.4, 2.6-7)

The quality of the beet was measured by analysis and has been shown in various formats. The levels of nitrogen (mg N/100g sugar) are all low, reflecting the high yields on light soils with low N availability (values should be less than 150). Potassium levels (mg K/100g sugar) are all within the range of 1000 ± 200 . Sodium levels (mg Na/100 g sugar) are within 100 ± 50 (the treatments 2-4 had sodium included in farm standard applications). Analysis of the beet showed that the concentrations of mainly nitrogen and potassium had been raised by the treatments.

Residual N (appendix 2.8)

Soil nitrogen levels after harvest were all low and therefore there is not a risk of excess nitrate due to the treatments.

VALUE OF COMPOST

Based on the nutrient analysis of the compost and the cost of inorganic fertilizers, the value of the major chemical nutrients contained is £4.75 per tonne (at £0.30/kg nitrogen, £0.30/kg phosphate, £0.20 kg potash and £0.20/kg sulphur). From this, the additional haulage and spreading costs need to be deducted (£2-3/tonne). Not all of the nutrients are immediately available to the crops being grown in the first year and so in purely chemical terms the value of compost to a farm is low if the crop response in the first year alone is considered. Much of the P and K is likely to become available for crop uptake over a period of years, becoming a component of a rotational fertilizer policy.

However, there are benefits from the addition of organic matter to soils that require long term trials to demonstrate the value of compost. The benefits may potentially include improved water retention and irrigation efficiency, reduced tillage costs as a result of improved soil structure, and the reduction in soil borne diseases. None of these benefits were clearly demonstrated in these one year trials. There is also some small liming value that will be of benefit on acid soils.

Organic farming systems, especially in areas away from animal production, often have the requirement for additional nutrients and this could be met from composted green waste. This sector is more likely to value well composted and quality assured products than general agriculture in the short term. However, certain soils within general agriculture could be targeted e.g. low organic matter, acid, sandy soils and heavy clays where crop responses or management benefits are likely to be greater, leading to increased perception of value.

CONCLUSIONS

The potatoes responded in terms of yield to the addition of compost. However, this crop has a high demand for immediately available nitrogen and phosphate which cannot be supplied by compost alone. The compost did supply high levels of potash which potentially has beneficial effects on dry matter content and reduced bruising in the tubers in storage. Benefits might also be found from the reduction in soil borne diseases but would require further trials to be confirmed as in the potato trial only small, not statistically significant effects were seen.

Sugarbeet requires less nitrogen than potatoes and compost may well be able to supply all, or most, of the nutrients for a good crop. The less immediate availability of the nutrients in the compost compared with chemical fertilizers may mean that all nutrients may be safely applied in the seedbed, saving top dressing operations. Beet and sugar quality were maintained where compost was applied.

Due to the relatively wet year, other benefits of compost addition such as improved water retention could not be seen. The value of compost to general agriculture is low but could be improved if targeted at organic farming systems, or farms with soils that are particularly responsive.

To add value to compost in agriculture it is recommended that longer term trials over three years be carried out so that a more complete evaluation and appraisal of benefits can be conducted.

APPENDICES - STATISTICAL ANALYSIS OF RESULTS

Appendix 1.1

Trial Id: 991640 Potatoes

Client & Client Ref: Suffolk Waste Disposal Company

MAIN EFFECTS

	NUMBER PLANTS/SQM 26/5/99	NUMBER PLANTS 000S/HA 26/5/99	COLOUR SCORE 0-10 17/6/99	VIGOUR SCORE 0-10 17/6/99	COLOUR SCORE 0-10 19/7/99	VIGOUR SCORE 0-10 19/7/99
Treatments						
Untreated control	3.72 ab	37.16 ab	6.00 a	4.00 a	5.00 a	4.25 a
Base inorganic Fert+N top dressing	3.74 ab	37.43 ab	8.50 b	8.00 c	7.25 b	7.00 cd
50t/ha compost+base inorganic fert+N top dressing	3.77 ab	37.70 ab	8.75 b	9.50 d	7.50 b	7.25 d
100t/ha compost+base inorganic fert+N top dressing	3.69 ab	36.89 ab	8.50 b	8.75 cd	7.00 b	6.50 bcd
50 t/ha compost	3.28 a	32.79 a	6.75 a	5.75 b	5.25 a	5.25 ab
100 t/ha compost	3.50 ab	34.97 ab	6.25 a	6.25 b	5.25 a	5.75 bc
50 t/ha compost + N top dressing	4.26 b	42.62 b	8.50 b	8.75 cd	6.25 ab	6.75 cd
100 t/ha compost + N top dressing	3.80 ab	37.98 ab	8.25 b	7.75 c	6.25 ab	6.00 bcd
LSD (0.05)	0.690	6.903	1.174	1.405	1.270	1.270
LSD (0.01)	0.940	9.398	1.598	1.912	1.729	1.729
SIGNIFICANCE	NS	NS	**	**	**	**
CV%	12.62	12.62	10.38	13.01	13.88	14.17
GM	3.72	37.19	7.69	7.34	6.22	6.09
SE PER PLOT	0.469	4.694	0.798	0.955	0.863	0.863

Appendix 1.2

Trial Id: 991640 Potatoes

Client & Client Ref: Suffolk Waste Disposal Company

MAIN EFFECTS

	POTATO LEAVES % N 15/7/99	POTATO LEAVES % P 15/7/99	POTATO LEAVES % K 15/7/99	POTATO LEAVES % Mg 15/7/99	POTATO LEAVES % S 15/7/99	POTATO LEAVES Mn ppm 15/7/99
Treatments						
Untreated control	3.18 ab	0.20 d	2.68 a	0.36 d	0.66 b	591.3 abc
Base inorganic Fert+N top dressing	3.36 b	0.18 c	3.09 ab	0.33 cd	0.42 a	523.0 a
50t/ha compost+base inorganic fert+N top dressing	3.35 b	0.19 cd	3.45 bcd	0.22 b	0.45 a	579.3 abc
100t/ha compost+base inorganic fert+N top dressing	3.31 b	0.16 b	3.78 d	0.23 b	0.41 a	550.3 ab
50 t/ha compost	3.04 a	0.18 cd	3.20 bc	0.14 a	0.72 b	681.8 bc
100 t/ha compost	2.98 a	0.18 cd	3.65 cd	0.13 a	0.63 b	708.5 c
50 t/ha compost + N top dressing	3.18 ab	0.16 b	3.36 bcd	0.27 bc	0.49 a	587.3 abc
100 t/ha compost + N top dressing	3.16 ab	0.14 a	3.70 cd	0.23 b	0.50 a	586.5 abc
LSD (0.05)	0.191	0.015	0.474	0.070	0.106	119.42
LSD (0.01)	0.261	0.020	0.645	0.096	0.145	162.58
SIGNIFICANCE	**	**	**	**	**	+
CV%	4.08	5.87	9.58	20.22	13.53	13.5
GM	3.19	0.17	3.36	0.24	0.53	601.0
SE PER PLOT	0.130	0.010	0.322	0.048	0.072	81.21

Appendix 1.3

Trial Id: 991640 Potatoes

Client & Client Ref: Suffolk Waste Disposal Company

MAIN EFFECTS

	TUBER YIELD <40MM T/HA 20/9/99	TUBER YIELD 40-60MM T/HA 20/9/99	TUBER YIELD 60-80MM T/HA 20/9/99	TUBER YIELD >80MM T/HA 20/9/99	TOTAL TUBER YIELD T/HA 20/9/99
Treatments					
Untreated control	1.66 a	15.57 a	13.25 a	0.07 a	30.56 a
Base inorganic Fert+N top dressing	1.31 a	17.67 a	34.84 d	1.78 cd	55.59 d
50t/ha compost+base inorganic fert+N top dressing	1.02 a	14.80 a	37.91 d	2.02 cd	55.75 d
100t/ha compost+base inorganic fert+N top dressing	1.10 a	17.87 a	34.24 d	2.47 d	55.69 d
50 t/ha compost	1.33 a	17.05 a	19.33 b	0.17 a	37.89 b
100 t/ha compost	1.67 a	16.48 a	18.37 b	0.47 ab	37.00 b
50 t/ha compost + N top dressing	1.38 a	15.32 a	27.98 c	1.25 bc	45.94 c
100 t/ha compost + N top dressing	1.41 a	15.28 a	27.62 c	2.79 d	47.10 c
LSD (0.05)	0.581	3.135	4.146	1.002	4.941
LSD (0.01)	0.791	4.267	5.645	1.364	6.727
SIGNIFICANCE	NS	NS	**	**	**
CV%	29.02	13.11	10.56	49.50	7.35
GM	1.36	16.26	26.69	1.38	45.69
SE PER PLOT	0.395	2.132	2.820	0.681	3.360

Appendix 1.4

Trial Id: 991640 Potatoes

Client & Client Ref: Suffolk Waste Disposal Company

MAIN EFFECTS

	POTATO TUBER % S 21/9/99	POTATO TUBER % N 21/9/99	POTATO TUBER % P 21/9/99	POTATO TUBER % K 21/9/99	POTATO TUBER % Mg 21/9/99	POTATO TUBER % Ca 21/9/99
Treatments						
Untreated control	0.13 a	1.09 ab	0.22 ab	1.96 ab	0.10 abc	0.28 b
Base inorganic Fert+N top dressing	0.12 a	1.43 c	0.22 ab	1.91 a	0.09 ab	0.14 ab
50t/ha compost+base inorganic fert+N top dressing	0.13 a	1.47 c	0.24 b	2.13 bc	0.10 c	0.23 ab
100t/ha compost+base inorganic fert+N top dressing	0.12 a	1.42 c	0.22 ab	2.20 c	0.10 bc	0.13 a
50 t/ha compost	0.12 a	0.96 a	0.21 ab	2.08 abc	0.09 a	0.28 b
100 t/ha compost	0.14 a	1.12 ab	0.21 a	2.21 c	0.09 ab	0.16 ab
50 t/ha compost + N top dressing	0.13 a	1.35 bc	0.20 a	2.01 abc	0.10 abc	0.15 ab
100 t/ha compost + N top dressing	0.13 a	1.17 abc	0.21 ab	2.13 bc	0.09 abc	0.22 ab
LSD (0.05)	0.016	0.266	0.033	0.177	0.008	0.128
LSD (0.01)	0.022	0.362	0.044	0.241	0.012	0.174
SIGNIFICANCE	NS	**	NS	*	+	NS
CV%	8.59	14.46	10.31	5.79	6.14	44.13
GM	0.13	1.25	0.22	2.08	0.09	0.20
SE PER PLOT	0.011	0.181	0.022	0.120	0.006	0.087

Appendix 1.5

Trial Id: 991640 Potatoes

Client & Client Ref: Suffolk Waste Disposal Company

MAIN EFFECTS

	POTATO TUBER S YIELD KG/HA 21/9/99	POTATO TUBER N YIELD KG/HA 21/9/99	POTATO TUBER P YIELD KG/HA 21/9/99	POTATO TUBER K YIELD KG/HA 21/9/99	POTATO TUBER Mg YIELD KG/HA 21/9/99	POTATO TUBER Ca YIELD KG/HA 21/9/99
Treatments						
Untreated control	7.98 a	67.4 a	13.36 a	121.8 a	5.92 a	17.32 a
Base inorganic Fert+N top dressing	13.95 de	161.1 c	24.62 c	214.5 cd	10.14 bc	15.11 a
50t/ha compost+base inorganic fert+N top dressing	14.86 e	163.9 c	27.11 c	237.3 de	11.18 c	25.27 a
100t/ha compost+base inorganic fert+N top dressing	13.26 de	157.8 c	24.11 c	244.8 e	10.84 c	14.51 a
50 t/ha compost	9.26 a	72.9 a	16.02 ab	158.2 b	6.65 a	21.72 a
100 t/ha compost	9.91 ac	82.1 a	14.83 a	159.9 b	6.54 a	11.13 a
50 t/ha compost + N top dressing	12.12 cd	128.9 b	19.14 b	192.1 c	9.06 b	14.94 a
100 t/ha compost + N top dressing	12.11 bcd	110.1 b	19.60 b	199.9 c	8.75 b	20.33 a
LSD (0.05)	2.130	27.24	3.423	26.92	1.450	12.573
LSD (0.01)	2.900	37.09	4.660	36.65	1.974	17.117
SIGNIFICANCE	**	**	**	**	**	NS
CV%	12.40	15.7	11.73	9.6	11.42	48.74
GM	11.68	118.1	19.85	191.1	8.63	17.54
SE PER PLOT	1.449	18.53	2.328	18.31	0.986	8.550

Appendix 1.6

Trial Id: 991640 Potatoes

Client & Client Ref: Suffolk Waste Disposal Company

MAIN EFFECTS

	SOIL NH4-N 0-30CM KG/HA 17/9/99	SOIL NO3-N 0-30CM KG/HA 17/9/99	TOTAL SOIL MIN-N 0-30CM KG/HA 17/9/99
Treatments			
Untreated control	8.28 a	21.96 a	30.24 a
Base inorganic Fert+N top dressing	6.03 a	24.30 a	30.33 a
50t/ha compost+base inorganic fert+N top dressing	2.43 a	29.97 a	32.40 a
100t/ha compost+base inorganic fert+N top dressing	5.49 a	27.72 a	33.21 a
50 t/ha compost	3.96 a	29.70 a	33.66 a
100 t/ha compost	5.22 a	28.98 a	34.20 a
50 t/ha compost + N top dressing	4.68 a	29.79 a	34.47 a
100 t/ha compost + N top dressing	5.13 a	25.56 a	30.69 a
LSD (0.05)	5.198	7.491	6.504
LSD (0.01)	7.077	10.199	8.855
SIGNIFICANCE	NS	NS	NS
CV%	68.60	18.70	13.65
GM	5.15	27.25	32.40
SE PER PLOT	3.535	5.094	4.423

Appendix 1.7

Trial Id: 991640 Potatoes
 Client & Client Ref: Suffolk Waste Disposal Company

MAIN EFFECTS

	PERCENT MOISTURE 21/9/99	PERCENT BRUISED 28/9/99	AVERAGE % BRIUSING 24/9/99
Treatments			
Untreated control	79.67 ab	0.00 a	0.00 a
Base inorganic Fert+N top dressing	79.76 ab	1.50 a	0.06 a
50t/ha compost+base inorganic fert+N top dressing	79.95 ab	0.00 a	0.00 a
100t/ha compost+base inorganic fert+N top dressing	80.08 ab	1.50 a	0.18 a
50 t/ha compost	79.87 ab	1.50 a	0.03 a
100 t/ha compost	80.36 b	0.00 a	0.01 a
50 t/ha compost + N top dressing	79.20 a	0.75 a	0.03 a
100 t/ha compost + N top dressing	79.97 ab	0.00 a	0.00 a
LSD (0.05)	0.995	2.484	0.187
LSD (0.01)	1.354	3.381	0.255
SIGNIFICANCE	NS	NS	NS
CV%	0.85	257.37	339.45
GM	79.86	0.66	0.04
SE PER PLOT	0.676	1.689	0.127

Appendix 1.8

Trial Id: 991640 Potatoes

Client & Client Ref: Suffolk Waste Disposal Company

MAIN EFFECTS - PERCENTAGE OF TUBERS

	PERCENT HOLLOW HEART 28/9/99	PERCENT VASCULAR BROWNING 28/9/99	PERCENT BLACK LEG 28/9/99	PERCENT INTERNAL RUST SPOT 28/9/99	PERCENT INTERNAL BROWNING 28/9/99	PERCENT SPRAING 28/9/99
Treatments						
Untreated control	3.25 a	50.00 a	9.75 a	9.00 a	0.75 a	0.75 a
Base inorganic Fert+N top dressing	4.00 a	48.25 a	8.00 a	3.25 a	0.75 a	1.50 a
50t/ha compost+base inorganic fert+N top dressing	4.00 a	49.25 a	1.50 a	7.50 a	0.00 a	0.75 a
100t/ha compost+base inorganic fert+N top dressing	2.25 a	45.00 a	3.00 a	3.00 a	0.00 a	0.75 a
50 t/ha compost	1.50 a	44.25 a	4.25 a	7.50 a	0.00 a	0.75 a
100 t/ha compost	2.25 a	40.00 a	8.00 a	4.75 a	3.00 b	1.50 a
50 t/ha compost + N top dressing	4.25 a	54.00 a	5.25 a	0.75 a	0.00 a	1.50 a
100 t/ha compost + N top dressing	0.75 a	50.75 a	2.25 a	4.00 a	0.00 a	0.75 a
LSD (0.05)	5.859	16.891	7.302	7.858	1.129	3.030
LSD (0.01)	7.977	22.996	9.941	10.698	1.537	4.125
SIGNIFICANCE	NS	NS	NS	NS	**	NS
CV%	143.26	24.09	94.58	107.55	136.47	199.80
GM	2.78	47.69	5.25	4.97	0.56	1.03
SE PER PLOT	3.985	11.486	4.965	5.344	0.768	2.061

Appendix 1.9

Trial Id: 991640 Potatoes

Client & Client Ref: Suffolk Waste Disposal Company

MAIN EFFECTS - AVERAGE % DISEASE IN TUBERS

	AVERAGE VASCULAR BROWNING 1-10 24/9/99	AVERAGE % HOLLOW HEART 24/9/99	AVERAGE % BLACK LEG 24/9/99	AVERAGE % INTERNAL RUST SPOT 24/9/99	AVERAGE % INTERNAL BROWNING 24/9/99	AVERAGE % SPRAING 24/9/99
Treatments						
Untreated control	0.90 b	0.15 a	0.36 ab	0.15 a	0.08 ab	0.02 a
Base inorganic Fert+N top dressing	0.69 ab	0.12 a	0.23 ab	0.03 a	0.08 ab	0.07 a
50t/ha compost+base inorganic fert+N top dressing	0.71 ab	0.29 a	0.33 ab	0.18 a	0.00 a	0.08 a
100t/ha compost+base inorganic fert+N top dressing	0.61 a	0.23 a	0.05 a	0.05 a	0.00 a	0.02 a
50 t/ha compost	0.57 a	0.17 a	0.87 b	0.12 a	0.00 a	0.02 a
100 t/ha compost	0.61 a	0.04 a	0.38 ab	0.05 a	0.16 b	0.02 a
50 t/ha compost + N top dressing	0.72 ab	0.14 a	0.42 ab	0.03 a	0.00 a	0.06 a
100 t/ha compost + N top dressing	0.78 ab	0.04 a	0.11 ab	0.07 a	0.00 a	0.01 a
LSD (0.05)	0.205	0.288	0.706	0.172	0.149	0.129
LSD (0.01)	0.279	0.393	0.961	0.234	0.203	0.175
SIGNIFICANCE	+	NS	NS	NS	NS	NS
CV%	19.96	133.55	140.07	138.72	249.17	246.78
GM	0.70	0.15	0.34	0.08	0.04	0.04
SE PER PLOT	0.139	0.196	0.480	0.117	0.101	0.087

Appendix 2.1

Trial Id: 991641 Sugarbeet

Client & Client Ref: Suffolk Waste Disposal Company

MAIN EFFECTS

	NUMBER PLANTS/SQM 4/6/99	COLOUR SCORE 0-10 17/6/99	VIGOUR SCORE 0-10 17/6/99	COLOUR SCORE 0-10 19/7/99	VIGOUR SCORE 0-10 19/7/99	VIGOUR SCORE 0-10 19/8/99
Treatments						
Untreated control	10.85 a	6.50 a	5.75 a	5.75 a	5.50 ab	5.75 ab
Base inorganic Fert+N top dressing	10.95 a	7.25 ab	7.50 b	8.00 bc	7.50 d	8.00 de
50t/ha compost+base inorganic fert+N top dressing	11.00 a	7.50 b	7.25 b	8.00 bc	7.75 d	8.25 de
100t/ha compost+base inorganic fert+N top dressing	10.65 a	7.50 b	7.50 b	8.50 c	8.25 d	8.75 e
50 t/ha compost	11.10 a	7.25 ab	6.75 ab	5.25 a	5.00 a	5.50 a
100 t/ha compost	11.15 a	7.25 ab	6.50 ab	7.50 bc	7.25 cd	8.00 de
50 t/ha compost + N top dressing	10.70 a	7.50 b	6.75 ab	7.00 b	6.25 bc	6.75 bc
100 t/ha compost + N top dressing	10.85 a	7.75 b	6.75 ab	7.75 bc	7.75 d	7.50 cd
LSD (0.05)	0.633	0.872	1.142	1.010	1.186	1.046
LSD (0.01)	0.861	1.186	1.554	1.375	1.615	1.424
SIGNIFICANCE	NS	NS	+	**	**	**
CV%	3.94	8.10	11.34	9.51	11.68	9.73
GM	10.91	7.31	6.84	7.22	6.91	7.31
SE PER PLOT	0.430	0.593	0.776	0.687	0.806	0.711

Appendix 2.2

Trial Id: 991641 Sugarbeet

Client & Client Ref: Suffolk Waste Disposal Company

MAIN EFFECTS

	COLOUR SCORE 0-10 27/9/99	VIGOUR SCORE 0-10 27/9/99
Treatments		
Untreated control	5.50 a	5.75 ab
Base inorganic Fert+N top dressing	7.50 bc	7.75 cd
50t/ha compost+base inorganic fert+N top dressing	8.25 c	8.25 d
100t/ha compost+base inorganic fert+N top dressing	8.25 c	8.25 d
50 t/ha compost	5.25 a	5.00 a
100 t/ha compost	7.25 bc	7.00 c
50 t/ha compost + N top dressing	7.25 bc	6.75 bc
100 t/ha compost + N top dressing	7.00 b	7.00 c
LSD (0.05)	1.010	1.130
LSD (0.01)	1.375	1.539
SIGNIFICANCE	**	**
CV%	9.77	11.03
GM	7.03	6.97
SE PER PLOT	0.687	0.769

Appendix 2.3

Trial Id: 991641 Sugarbeet

Client & Client Ref: Suffolk Waste Disposal Company

MAIN EFFECTS

	LEAVES % N 29/7/99	LEAVES % P 29/7/99	LEAVES % K 29/7/99	LEAVES % S 29/7/99	LEAVES % Mg 29/7/99	LEAVES Mn ppm 29/7/99
Treatments						
Untreated control	2.71 a	0.43 cd	4.83 d	0.36 ab	0.53 ab	170.5 b
Base inorganic Fert+N top dressing	3.27 bc	0.32 ab	2.81 a	0.31 a	0.53 ab	227.0 c
50t/ha compost+base inorganic fert+N top dressing	3.36 c	0.31 ab	3.36 ab	0.34 a	0.45 a	140.3 ab
100t/ha compost+base inorganic fert+N top dressing	3.16 bc	0.27 a	3.06 a	0.36 ab	0.45 a	112.3 a
50 t/ha compost	2.77 a	0.36 abcd	4.56 cd	0.37 ab	0.61 b	150.0 ab
100 t/ha compost	2.93 ab	0.34 abc	3.97 bc	0.36 ab	0.44 a	114.8 a
50 t/ha compost + N top dressing	2.90 ab	0.45 d	4.96 d	0.37 ab	0.54 ab	189.3 bc
100 t/ha compost + N top dressing	3.04 abc	0.40 bcd	4.83 d	0.41 b	0.51 ab	150.0 ab
LSD (0.05)	0.346	0.087	0.656	0.058	0.100	50.46
LSD (0.01)	0.471	0.119	0.892	0.079	0.137	68.70
SIGNIFICANCE	**	**	**	+	*	**
CV%	7.79	16.58	11.02	10.89	13.50	21.9
GM	3.02	0.36	4.05	0.36	0.51	156.8
SE PER PLOT	0.235	0.059	0.446	0.039	0.068	34.31

Appendix 2.4

Trial Id: 991641 Sugarbeet

Client & Client Ref: Suffolk Waste Disposal Company

MAIN EFFECTS

	BEEET K (MEQ/100G BEEET)	BEEET Na (MEQ/100G BEEET)	BEEET AMINO N (MEQ/100G BEEET)	SUGAR AMINO N (MEQ/100G SUGAR)	Mg N/100G SUGAR	Mg K/100G SUGAR	Mg Na/100G SUGAR
Treatments							
Untreated control	3.83 a	0.42 a	0.14 a	11.93 a	11.88 a	889 a	57.3 a
Base inorganic Fert+N top dressing	4.00 ab	0.80 b	0.34 b	28.25 b	28.50 b	929 ab	109.6 b
50t/ha compost+base inorganic fert+N top dressing	4.50 cd	0.76 b	0.37 b	30.65 bc	30.54 b	1050 cd	104.4 b
100t/ha compost+base inorganic fert+N top dressing	4.90 e	0.83 b	0.50 c	41.78 c	41.77 c	1139 e	113.4 b
50 t/ha compost	4.15 abc	0.39 a	0.11 a	9.00 a	9.03 a	977 bc	54.5 a
100 t/ha compost	4.78 de	0.43 a	0.24 ab	19.78 ab	19.71 ab	1095 de	58.1 a
50 t/ha compost + N top dressing	4.33 bc	0.42 a	0.23 ab	19.48 ab	19.30 ab	1011 bcd	57.9 a
100 t/ha compost + N top dressing	4.73 de	0.42 a	0.25 ab	20.75 ab	20.75 ab	1093 de	57.7 a
LSD (0.05)	0.339	0.082	0.133	11.134	11.060	80.0	11.57
LSD (0.01)	0.462	0.112	0.181	15.158	15.058	108.9	15.75
SIGNIFICANCE	**	**	**	**	**	**	**
CV%	5.24	9.98	33.18	33.35	33.15	5	10.3
GM	4.40	0.56	0.27	22.70	22.69	1023	76.6
SE PER PLOT	0.231	0.056	0.090	7.571	7.521	54.4	7.87

Appendix 2.5

Trial Id: 991641 Sugarbeet

Client & Client Ref: Suffolk Waste Disposal Company

MAIN EFFECTS

	PERCENT SUGAR	WEIGHT OF BEET/PLOT (KG)	BEET YIELD T/HA	BEET SUGAR YIELD T/HA	PERCENT MOISTURE 13/10/99
Treatments					
Untreated control	16.79 ab	99.7 a	55.39 a	9.30 a	75.57 a
Base inorganic Fert+N top dressing	16.79 ab	127.8 de	70.97 de	11.92 cd	76.66 c
50t/ha compost+base inorganic fert+N top dressing	16.71 ab	130.1 de	72.28 de	12.08 d	76.38 bc
100t/ha compost+base inorganic fert+N top dressing	16.78 ab	134.8 e	74.86 e	12.56 d	76.13 abc
50 t/ha compost	16.56 a	99.1 a	55.03 a	9.12 a	76.21 abc
100 t/ha compost	17.01 b	126.3 cd	70.14 cd	11.93 cd	75.72 ab
50 t/ha compost + N top dressing	16.70 a	115.9 b	64.36 b	10.75 b	76.22 abc
100 t/ha compost + N top dressing	16.87 ab	119.5 bc	66.36 bc	11.20 bc	76.08 abc
LSD (0.05)	0.279	7.68	4.269	0.791	0.705
LSD (0.01)	0.380	10.46	5.812	1.077	0.959
SIGNIFICANCE	NS	**	**	**	+
CV%	1.13	4.4	4.39	4.84	0.63
GM	16.78	119.1	66.17	11.11	76.12
SE PER PLOT	0.190	5.23	2.903	0.538	0.479

Appendix 2.6

Trial Id: 991641 Sugarbeet

Client & Client Ref: Suffolk Waste Disposal Company

MAIN EFFECTS

	BEET % N 13/10/99	BEET % P 13/10/99	BEET % K 13/10/99	BEET % Mg 13/10/99	BEET % S 13/10/99	BEET % Ca 13/10/99
Treatments						
Untreated control	0.41 ab	0.12 abc	0.65 a	0.08 abc	0.04 a	0.18 ab
Base inorganic Fert+N top dressing	0.43 b	0.13 c	0.71 ab	0.08 abc	0.03 a	0.17 ab
50t/ha compost+base inorganic fert+N top dressing	0.46 c	0.13 bc	0.78 ab	0.08 abc	0.04 a	0.17 ab
100t/ha compost+base inorganic fert+N top dressing	0.43 b	0.12 abc	0.81 b	0.08 ab	0.03 a	0.10 a
50 t/ha compost	0.40 ab	0.13 abc	0.69 ab	0.09 c	0.03 a	0.22 b
100 t/ha compost	0.42 ab	0.12 ab	0.78 ab	0.08 ab	0.04 a	0.19 b
50 t/ha compost + N top dressing	0.39 a	0.11 a	0.66 a	0.09 bc	0.04 a	0.18 ab
100 t/ha compost + N top dressing	0.41 ab	0.12 abc	0.68 ab	0.07 a	0.05 a	0.20 b
LSD (0.05)	0.028	0.013	0.124	0.011	0.025	0.071
LSD (0.01)	0.039	0.018	0.169	0.015	0.035	0.097
SIGNIFICANCE	**	NS	+	NS	NS	NS
CV%	4.61	7.23	11.69	9.47	46.32	27.71
GM	0.42	0.12	0.72	0.08	0.04	0.18
SE PER PLOT	0.019	0.009	0.084	0.008	0.017	0.049

Appendix 2.7

Trial Id: 991641 Sugarbeet
 Client & Client Ref: Suffolk Waste Disposal Company

MAIN EFFECTS

	BEEET N YIELD KG/HA	BEEET P YIELD KG/HA	BEEET K YIELD KG/HA	BEEET Mg YIELD KG/HA	BEEET S YIELD KG/HA	BEEET Ca YIELD KG/HA
Treatments						
Untreated control	55.24 ab	16.55 a	88.7 a	10.90 a	5.18 a	23.96 ab
Base inorganic Fert+N top dressing	70.36 d	21.98 d	118.3 bc	13.24 b	5.26 a	27.77 ab
50t/ha compost+base inorganic fert+N top dressing	78.96 f	21.78 d	133.2 cd	13.64 b	7.64 a	29.17 ab
100t/ha compost+base inorganic fert+N top dressing	76.85 ef	21.44 cd	143.7 d	13.41 b	5.99 a	18.42 a
50 t/ha compost	52.25 a	16.34 a	90.5 a	11.45 ab	3.85 a	28.43 ab
100 t/ha compost	71.86 de	19.97 cd	133.2 cd	12.75 ab	6.09 a	32.44 b
50 t/ha compost + N top dressing	60.01 bc	17.17 ab	101.3 ab	12.99 ab	5.32 a	27.52 ab
100 t/ha compost + N top dressing	64.23 c	19.05 bc	107.3 ab	11.53 ab	7.90 a	30.58 ab
LSD (0.05)	5.768	2.359	22.73	2.066	4.147	11.227
LSD (0.01)	7.852	3.212	30.95	2.813	5.646	15.285
SIGNIFICANCE	**	**	**	+	NS	NS
CV%	5.92	8.32	13.5	11.25	47.77	27.98
GM	66.22	19.29	114.5	12.49	5.90	27.29
SE PER PLOT	3.922	1.604	15.46	1.405	2.820	7.635

Appendix 2.8

Trial Id: 991641 Sugarbeet
 Client & Client Ref: Suffolk Waste Disposal Company

MAIN EFFECTS

	SOIL NH4-N 0-30CM ppm 1/10/99	SOIL NO3-N 0-30CM ppm 1/10/99	SOIL NH4-N 0-30CM KG/HA 1/10/99	SOIL NO3-N 0-30CM KG/HA 1/10/99
Treatments				
Untreated control	1.48 b	2.83 a	5.31 b	10.17 a
Base inorganic Fert+N top dressing	0.88 ab	2.93 a	3.15 ab	10.53 a
50t/ha compost+base inorganic fert+N top dressing	1.30 ab	2.95 a	4.68 ab	10.62 a
100t/ha compost+base inorganic fert+N top dressing	0.73 a	2.63 a	2.61 a	9.45 a
50 t/ha compost	1.05 ab	2.80 a	3.78 ab	10.08 a
100 t/ha compost	1.38 ab	2.98 a	4.95 ab	10.71 a
50 t/ha compost + N top dressing	1.05 ab	2.78 a	3.78 ab	9.99 a
100 t/ha compost + N top dressing	0.85 ab	2.93 a	3.06 ab	10.53 a
LSD (0.05)	0.656	0.740	2.360	2.665
LSD (0.01)	0.892	1.008	3.213	3.629
SIGNIFICANCE	NS	NS	NS	NS
CV%	40.99	17.66	40.99	17.66
GM	1.09	2.85	3.92	10.26
SE PER PLOT	0.446	0.503	1.605	1.81