LEVINGTON AGRICULTURE

REPORT

by P A Wallace

November 2000

Report on LA Project 00155

Field Trials on

Compost – winter wheat

For: Enventure Research

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Trial work commenced: 7.3.00
Trial work completed: 31.8.00

Carried out by:

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ABBREVIATIONS

cm	centimetre
CV%	Co-efficient of Variation
DM	dry matter
g	gram
GM	General Mean
ha	hectare
K, K_2O	potassium, potash
kg	kilogram
l	litre
LA	Levington Agriculture Ltd
LSD	Least Significant Difference
Mg	magnesium
mg	milligram
mm	millimetre
N	nitrogen
NS	Not Significant
P, P_2O_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

OBJECTIVE

To assess the continued effects of composted green waste to land in a second year by growing winter wheat in order to carry out a market evaluation of the compost in agriculture.

METHODS

Year 1 1999 Sugarbeet Treatments

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

	Sugarbeet
Base inorganic fertilizer	50 kg N no phosphate 100 kg K_20 150 kg Na (400 kg salt)
N top dressing	50 kg N/ha
Timing of top dressing	2 true leaf

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

50 t/ha	100 t/ha
260 kg N	520 kg N
220 kg P_2O_5	440 kg P_2O_5
393 kg K_2O	786 kg K_20
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 sugarbeet trial gave positive responses in terms of yield to the applied compost (see 1999 report).

Year 2 2000 Winter wheat Treatments

The treatments applied to the wheat were of nitrogen only to allow the assessment of the carryover effects of the compost applied in 1999. The treatments were applied to the same plots as in 1999.

Nitrogen kg/ha

	February	March
1	0	0
2	40	160
3	40	160
4	40	160
5	0	0
6	0	0
7	40	80
8	40	80

The trial, with four replicates of each treatment, was of randomised block design and statistically analysed accordingly. The soil was sampled and analysed by plot in the spring and the soil structure measured by penetrometer. The crop was assessed for colour and vigour during growth and crop samples taken in May for nutrient content. At harvest the yield of grain was measured and the grain analysed for nitrogen and sulphur contents. Full details are shown in the attached Project Plan.

Table 1 Trial Diary

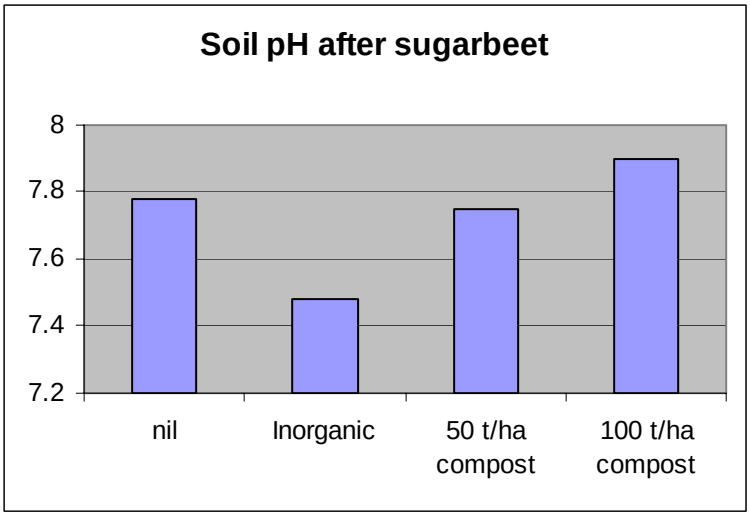
7.3.00	Soil sampled for analysis taken from growing crop
7.3.00	Early top dressing N applied at growth stage 21
19.4.00	Top dressing N applied at growth stage 30-31
17.5.00	Plant samples taken, vigour assessed
15.6.00	Photos taken and colour and vigour assessed
24.6.00	Plant heights recorded
31.8.00	Trial harvested

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).

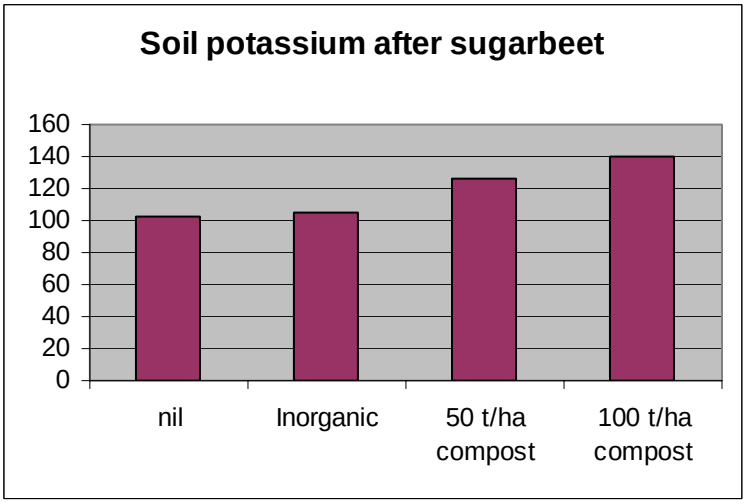
Soil measurements

The residual effects on soil fertility were measured in March 2000 by analysing the soil in each plot. Where inorganic fertilizer alone had been applied to the sugarbeet, the soil pH had fallen compared with the unfertilized soil (Graph 1). The application of compost in addition to inorganic fertilizer counteracted this acidification. The highest pH was found where 100 t/ha compost alone had been applied the previous year. There were no significant effects on soil phosphorus levels, which were generally high (index 3). Soil potassium was significantly raised by the previous compost additions, more so by the higher rate of compost than the lower rate, as would be expected (Graph 2). There were no significant differences in soil magnesium levels due to the previous year's treatments. Soil structural effects were measured by using a penetrometer, but no significant differences were found between treatments.

Graph 1



Graph 2



Crop assessment

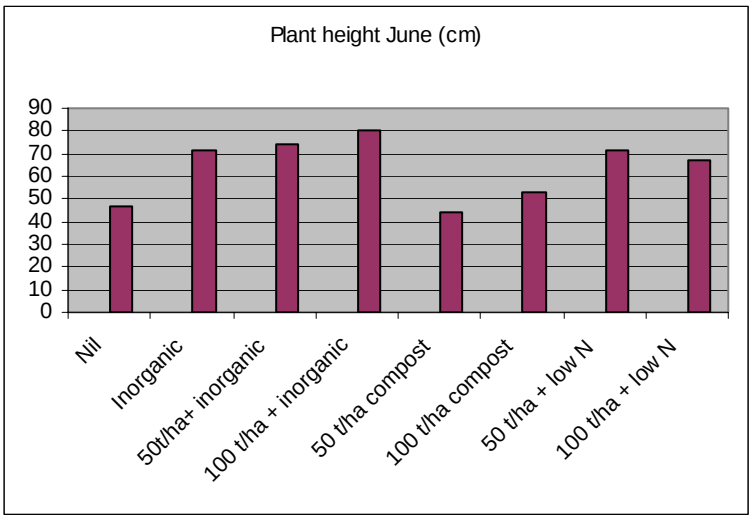
Due to the actual crop growth stages, the fertilizer nitrogen top dressings in 2000 were applied in early March and April. Crop samples were taken from the plots in mid-May. These showed that there was a response to the applied fertilizer but that where only the residual compost was being tested, there were no increases in crop nitrogen levels. The increased supply of nitrogen, and hence rooting, led to greater phosphorus contents in the plants were nitrogen had been applied in 2000, as was the case for potassium. However, with potassium there was an additional effect from the compost applied the previous year.

Magnesium is also taken up in proportion to improved rooting from higher nitrogen levels in the soil as was seen. Magnesium levels in the crop were generally low, as were sulphur levels. There was residual benefit from the compost with regards sulphur supply. The N:S ratio is regarded as being an indication of the ability of the soil to supply adequate sulphur to utilise nitrogen effectively. The ratio should be below 17, ideally less than 14. The addition of 100 t/ha compost the previous year led to N:S ratios being satisfactory at 14 where nitrogen fertilizer had been applied (treatment 4), whereas where no compost had been applied, in treatment 2, the N:S ratio was 22. 50 t/ha of compost appeared not to supply enough sulphur.

This effect on N:S ratio is probably the reason why, with increased compost addition the previous year, where inorganic nitrogen was applied, the crop vigour assessed in May and June was improved. Inadequate nitrogen was being released from the compost only plots to adequately feed the winter wheat, which has a relatively high demand for nitrogen amongst the cereal crops. At this stage a reduced rate of nitrogen on top of last year's compost, treatments 7 and 8, also appeared to be doing well in terms of crop colour and vigour.

The difference in plant heights (Graph 3) was clearly visible and on measurement reflected the nitrogen supply and the effects of sulphur noted above.

Graph 3

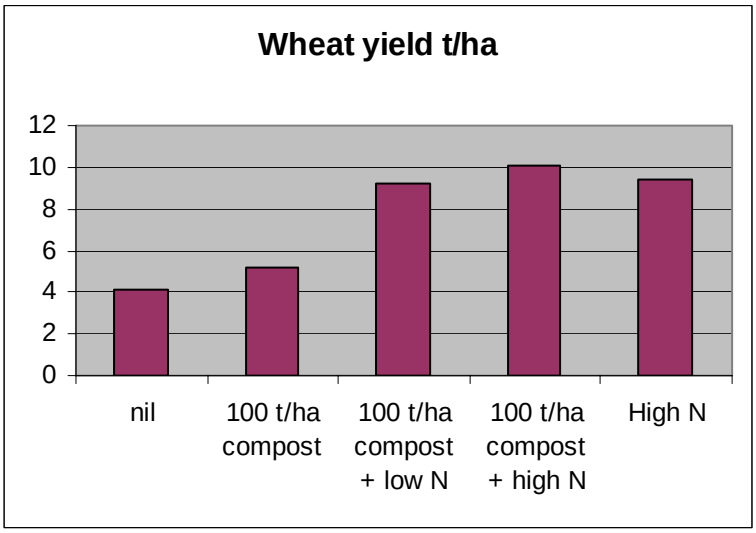


Harvest

The lowest yields of grain were from the untreated control and the plots were 50 t/ha compost had been applied only the previous year. Where 100 t/ha compost only had been applied there was a small yield response of 1 t/ha. With reduced nitrogen top dressings (less 80 kg N/ha) the yields were equal to the inorganic fertilizer alone treatment at over 9 t/ha. The highest yields were obtained from 100 t/ha compost the previous year plus the full nitrogen top dressing in 2000 (Graph 4). These effects will have been due to the small supply of nitrogen and probably a more important supply of sulphur from the compost.

Grain specific weight increased in proportion to nitrogen supply. Sulphur in the grain is likely to have improved quality effects, not measured. The analysis of the grain for N and S agreed with the arguments put forward above. Sulphur was limiting and was corrected by compost addition. However, at harvest the differences in contents of the grain were not so evident. This may have been due to the improvements in rooting depth as the season progressed, with sulphur at lower soil depths being utilised.

Graph 4



VALUE OF COMPOST IN YEAR 2

Responses were seen from the compost in terms of residual nitrogen increasing yield by 1 tonne from 100t compost where no other fertilizer was applied. Where fertilizers were applied the benefit of secondary nutrients were demonstrated, such as sulphur.

200 kg/ha of inorganic nitrogen raised yields by 5.4 t/ha at a cost of (200 kg N at 35p/kg at 2000 prices) £13 per tonne of grain, so the residual value of 100 t compost giving 1 tonne of grain was 13p per tonne of compost for its nitrogen content. The typical economic return on the inorganic fertilizer at £4 in grain per £1 spent was confirmed in this trial.

Where low N was applied with compost, 80 kg N was saved at a value of £28/ha with yields almost the same as the farm standard, high N treatment. Here the compost provided addition nutrients as well as nitrogen. This valued the residual effect of 100 t of compost at 28p per tonne.

CONCLUSIONS

The continued release of nutrients from the compost applied in the previous year was demonstrated. The soil nutrient reserves were also shown to have been improved, leading to yield benefits. In comparison with the economic return from inorganic fertilizers, the value of a tonne of compost applied for its nutrient content is low, at £1-3 over the rotation, delivered and spread.

Further benefits of the compost need to be shown, such as disease suppression, soil structure and the effects on water supply in a dry year, in order to raise the value of compost above these levels. This will require a continuation of the trial for at least a third year, with more compost being applied.

APPENDICES - STATISTICAL ANALYSIS OF RESULTS

Appendix 1.1
Trial Id: 001550 Loudham
Client & Client Ref: Enventure Research

MAIN EFFECTS

			SOIL pH 10/3/00	SOIL P MG/L 10/3/00	SOIL K MG/L 10/3/00	SOIL Mg MG/L 10/3/00	AVERAGE PENETROMETER READING 21/3/00
N Kg/ha	February	March					
1	0	0	7.78 bc	73.75 a	102.5 a	51.25 a	66.25 a
2	40	160	7.48 a	71.75 a	105.0 a	47.00 a	68.38 a
3	40	160	7.53 ab	72.25 a	121.0 ab	52.50 a	71.13 a
4	40	160	7.85 c	72.50 a	159.0 c	55.25 a	60.75 a
5	0	0	7.75 bc	81.75 a	126.0 ab	53.25 a	68.63 a
6	0	0	7.90 c	78.00 a	139.5 bc	56.00 a	72.75 a
7	40	80	7.58 ab	77.50 a	123.8 ab	56.25 a	74.50 a
8	40	80	7.73 abc	79.25 a	142.0 bc	53.25 a	74.25 a
LSD (0.05)			0.247	11.320	29.91	8.341	14.797
LSD (0.01)			0.336	15.412	40.72	11.356	20.145
SIGNIFICANCE			*	NS	*	NS	NS
CV%			2.18	10.15	16.0	10.68	14.46
GM			7.70	75.84	127.3	53.09	69.58
SE PER PLOT			0.168	7.698	20.34	5.672	10.062
SED			0.119	5.443	14.38	4.011	7.115
Min. value			7.20	59.00	73.0	44.00	52.00
Max. value			8.10	92.00	183.0	67.00	93.50
Residual df			21	21	21	21	21
F Ratio			3.41	0.96	3.5	1.14	0.85
F Required			2.49	2.49	2.5	2.49	2.49
Probability %			1.367	100.000	1.207	37.864	100.000

Appendix 1.2
Trial Id: 001550 Loudham
Client & Client Ref: Enventure Research

MAIN EFFECTS

			WHEAT % N 17/5/00	WHEAT % P 17/5/00	WHEAT % K 17/5/00	WHEAT % Mg 17/5/00	WHEAT % S 17/5/00	LEAVES N:S RATIO 17/5/00
N Kg/ha	February	March						
1	0	0	1.44 a	0.31 a	2.41 a	0.07 a	0.12 ab	12.51 a
2	40	160	3.10 c	0.46 c	3.19 bc	0.10 cd	0.15 bc	22.22 b
3	40	160	3.01 c	0.46 c	3.40 c	0.10 c	0.15 c	20.42 b
4	40	160	3.12 c	0.46 c	3.86 d	0.11 d	0.22 d	14.00 a
5	0	0	1.36 a	0.32 a	2.43 a	0.08 ab	0.11 a	12.30 a
6	0	0	1.52 a	0.32 a	2.65 a	0.07 a	0.12 abc	12.22 a
7	40	80	2.21 b	0.40 b	3.05 b	0.08 b	0.14 abc	16.45 a
8	40	80	2.24 b	0.42 bc	3.35 bc	0.08 b	0.16 c	14.31 a
LSD (0.05)			0.216	0.036	0.300	0.008	0.032	3.881
LSD (0.01)			0.294	0.049	0.408	0.012	0.043	5.283
SIGNIFICANCE			**	**	**	**	**	**
CV%			6.52	6.15	6.70	6.67	14.79	16.97
GM			2.25	0.39	3.04	0.09	0.15	15.55
SE PER PLOT			0.147	0.024	0.204	0.006	0.022	2.639
SED			0.104	0.017	0.144	0.004	0.015	1.866
Min. value			1.29	0.30	2.32	0.06	0.10	10.49
Max. value			3.36	0.49	4.13	0.11	0.23	28.72
Residual df			21	21	21	21	21	21
F Ratio			107.11	30.03	25.13	21.27	10.85	8.52
F Required			2.49	2.49	2.49	2.49	2.49	2.49
Probability %			<0.001	<0.001	<0.001	<0.001	0.001	0.007

Appendix 1.3
Trial Id: 001550 Loudham
Client & Client Ref: Enventure Research

MAIN EFFECTS

			VIGOUR SCORE 0-10 15/5/00	COLOUR SCORE 0-5 15/6/00	VIGOUR SCORE 0-5 15/6/00	AVERAGE PLANT HEIGHT (CM)
N Kg/ha	February	March				
1	0	0	3.75 a	2.50 a	2.50 a	46.58 a
2	40	160	9.00 b	4.75 b	4.00 b	71.58 cd
3	40	160	9.50 b	4.50 b	4.50 bc	74.33 d
4	40	160	9.50 b	4.75 b	4.75 c	80.16 e
5	0	0	3.50 a	2.75 a	2.50 a	44.50 a
6	0	0	4.50 a	3.00 a	3.00 a	53.00 b
7	40	80	8.50 b	4.50 b	4.00 b	71.41 cd
8	40	80	8.50 b	4.75 b	4.75 c	67.16 c
LSD (0.05)			1.153	0.744	0.662	5.287
LSD (0.01)			1.570	1.013	0.901	7.199
SIGNIFICANCE			**	**	**	**
CV%			11.05	12.85	12.00	5.65
GM			7.09	3.94	3.75	63.59
SE PER PLOT			0.784	0.506	0.450	3.596
SED			0.554	0.358	0.318	2.542
Min. value			3.00	2.00	2.00	41.33
Max. value			10.00	5.00	5.00	84.00
Residual df			21	21	21	21
F Ratio			46.48	15.56	18.00	57.20
F Required			2.49	2.49	2.49	2.49
Probability %			<0.001	<0.001	<0.001	<0.001

Appendix 1.4
Trial Id: 001550 Loudham
Client & Client Ref: Enventure Research

MAIN EFFECTS

			GRAIN YIELD T/HA 31/8/00	GRAIN SPECIFIC WEIGHT KG/HL 31/8/00	GRAIN % N 31/8/00	GRAIN % S 31/8/00	GRAIN N:S RATIO 31/8/00	GRAIN N YIELD KG/HA 31/8/00	GRAIN S YIELD KG/HA 31/8/00
N Kg/ha	February	March							
1	0	0	4.10 a	72.61 a	1.23 a	0.08 a	14.76 ab	42.8 a	2.91 ab
2	40	160	9.41 cd	75.76 c	1.75 c	0.11 c	16.06 b	139.7 c	8.77 d
3	40	160	9.48 cd	76.70 c	1.72 c	0.11 c	16.05 b	138.3 c	8.64 d
4	40	160	10.08 d	75.81 c	1.68 c	0.11 c	15.87 b	144.0 c	9.07 d
5	0	0	3.96 a	72.21 a	1.21 a	0.08 a	14.70 ab	40.9 a	2.78 a
6	0	0	5.14 b	73.44 ab	1.18 a	0.08 a	14.00 a	51.7 a	3.69 b
7	40	80	9.11 c	75.48 c	1.50 b	0.10 b	15.51 ab	116.3 b	7.48 c
8	40	80	9.25 c	74.96 bc	1.34 ab	0.09 ab	15.21 ab	105.0 b	6.96 c
LSD (0.05)			0.742	1.851	0.179	0.009	1.457	16.42	0.844
LSD (0.01)			1.010	2.519	0.244	0.012	1.984	22.36	1.148
SIGNIFICANCE			**	**	**	**	+	**	**
CV%			6.67	1.69	8.40	6.47	6.49	11.5	9.12
GM			7.56	74.62	1.45	0.09	15.27	97.3	6.29
SE PER PLOT			0.504	1.258	0.122	0.006	0.991	11.17	0.574
SED			0.357	0.890	0.086	0.004	0.701	7.90	0.406
Min. value			3.52	70.10	1.07	0.08	12.30	32.9	2.37
Max. value			10.69	77.43	1.92	0.12	18.10	162.4	9.83
Residual df			21	21	21	21	21	21	21
F Ratio			111.21	6.90	15.77	14.02	2.24	65.6	89.96
F Required			2.49	2.49	2.49	2.49	2.49	2.5	2.49
Probability %			<0.001	0.027	<0.001	<0.001	7.220	<0.001	<0.001

Appendix 2

LEVINGTON AGRICULTURE

LA Project No	00155
Harvest Year	2000
Type of project	FIELD
Crop	WINTER WHEAT
Trial ID(s)	
001550	BGW

PROJECT PLAN

CLIENT

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CLIENT'S PROJECT NO:

TITLE: **FIELD TRIALS OF COMPOST**

OBJECTIVE: To assess the continued effects of adding composted green waste to land in a second year by growing winter wheat in order to carry out a market evaluation of the compost in agriculture.

TIMING:

Start of Trial Work: February2000
End of Trial Work: Harvest 2000
Report complete: Autumn 2000

	Name	Signature	Date
PREPARED BY:	M R Kemp		
APPROVED BY:	I D S Turner		
STUDY DIRECTOR:	M R Kemp		

Treatments

Nitrogen Kg/ha

	February	March
1	**0**	**0**
2	40	160
3	40	160
4	40	160
5	0	0
6	0	0
7	40	80
8	40	80

Treatment Application

Top dressing of N to be applied in Feb
Top dressing of N to be applied in March

Uniform Applications

All normal farmer inputs according to good agricultural practice with the exception of fertilizers and micronutrients

Design

Randomised block
8 treatments x 4 replicates = 32 plots, same randomisation as 991641

Statistical Analysis

Standard analysis of variance, means, CV%, LSD, SE and Duncan's MRT.

Dimensions

Plot size: minimum 6m x 10m, same as 991641
Total area: 0.19 ha per trial

Site Specification

Loudham

Variety

As planted by farmer

Assessments

Timing	Description
At marking out	Soil analysis (pH,P,K,Mg) and structure (penetrometer)
T1 application (Feb)	Colour and vigour
T2 application (Mar)	Colour and vigour
May 2000	Plant samples (N,P,K,Mg,S), colour and vigour
Harvest	Plot yield (2 cuts at 8m)
	Analyse grain for N and S content, and moisture and hectolitre weights

Other Records

Standard Soil Samples	**Ag 2.2**
Site Map + Field Plan	Ag 1.6
Application Details	Ag 2.6
Trial Diary	Ag 1.7

Data Retention

LA files.

Sample Retention

None required