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Other Experiments at Woburn

Rothamsted Research

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BARLEY

WOBURN

Residual effect of dung applied to Kale in 1932.

WB, LANSOME—1933

Plan and yields in lb., green weights

1	D2 43.0	O3 32.0	O2S 44.0	D0S 45.5	O0 33.0	D1 48.0	D3S 49.0	O1S 41.0	8
	D0 42.5	D1S 52.0	D3 46.0	O2 34.0	D2S 54.5	O1 39.5	O3S 47.5	O0S 44.5	
	O3 41.5	O2S 49.5	D2 47.0	O0 32.5	D1 42.5	D0S 58.5	O1S 46.5	D3S 53.5	NW ↑
	D1S 55.0	D0 40.5	O1 36.5	D2S 44.5	O3S 51.5	D3 48.0	O0S 43.0	O2 34.5	
	O2S 49.0	D2 42.5	D0S 51.5	D3S 49.0	O1S 43.5	O0 40.5	D1 43.0	O3 37.5	
	O0S 50.5	O1 38.0	O3S 49.0	D1S 48.0	D3 39.0	O2 42.0	D2S 50.0	D0 43.0	
	O1S 48.0	D3S 56.0	O0 36.0	O3 29.5	D0S 53.0	D2 44.0	O2S 43.0	D1 36.5	
57	D3 51.5	O0S 56.0	D1S 63.0	O1 39.5	O2 44.0	O3S 54.0	D0 49.0	D2S 47.5	64

SYSTEM OF REPLICATION : 1932. 8 × 8 Latin Square. 1933, Half the plots treated with sulphate of ammonia, the one degree of freedom for the interaction OvS × OvD × (0+3) v (1+2) being confounded with row differences between rows 1 and 2, 3 and 4, 5 and 6, 7 and 8. Columns are not orthogonal with the 1933 sulphate of ammonia and its interactions. (The continuation of the experiment in 1933 was not contemplated when it was originally designed.)

AREA OF EACH PLOT : 0.004591 acre (20 ft. × 10 ft.). Area harvested : 0.004238 acres.

TREATMENTS: 1932, Sulphate of ammonia at the rate of 0(0), 0.2(1), 0.4(2) and 0.8 cwt.(3) N per acre with and without dung (D and O) at the rate of 15 tons per acre. Basal (plots receiving no dung) : Superphosphate at the rate of 0.5 cwt. P₂O₅ per acre, and 30 per cent. potash manure salt at the rate of 1.0 cwt. K₂O per acre.

1933, No sulphate of ammonia and sulphate of ammonia at the rate of 0.2 cwt. N per acre (S).

CULTIVATIONS, ETC. : Dug : March 20th -27th. Harrowed : March 30th. Rolled : March 30th. Manures applied : March 31st. Seed sown : March 30th. Harvested : July 19th. Variety : Plumage Archer. Previous crop : Kale.

STANDARD ERROR PER PLOT : Green material : ±5.47 cwt. per acre or 5.75%.

**GREEN MATERIAL
YIELDS OF INDIVIDUAL TREATMENTS**

Cwt. per acre (±2.73)	No Nitrogen, 1933				Nitrogen, 1933			
	No N. 1932	0.2 cwt. N. 1932	0.4 cwt. N. 1932	0.8 cwt. N. 1932	No N. 1932	0.2 cwt. N. 1932	0.4 cwt. N. 1932	0.8 cwt. N. 1932
No Dung	74.8	80.8	81.4	74.0	102.2	94.3	97.7	106.4
Dung	92.2	89.5	93.0	97.2	109.8	114.8	103.5	109.3

MEAN OF NITROGEN AND NO NITROGEN, 1933

Cwt. per acre (±1.93)	No N., 1932	0.2 cwt. N., 1932	0.4 cwt. N., 1932	0.8 cwt. N., 1932	Mean (±0.967)	Difference (±1.37)
No Dung	88.5	87.6	89.5	90.2	89.0	+12.2
Dung	101.0	102.2	98.2	103.2	101.2	
Mean (±1.37) ..	94.8	94.9	93.8	96.7	95.1	
Increase (±1.93) ..		+0.1	-1.1	+2.9		

MEAN OF ALL 1932 TREATMENTS ADJUSTED FOR COLUMN DIFFERENCES

No N., 1933	84.7
N., 1933 ..	105.4
Difference ..	+20.7

PERCENTAGE DRY MATTER (BULKED REPLICATES)

	No Dung 1932	Dung 1932
No N., 1933	43.1	41.5
N., 1933	41.2	44.8

CONCLUSIONS

There is a significant residual effect of the dung applied in 1932, and a significant effect of the sulphate of ammonia applied in 1933, the increases in green material being :

15 tons dung applied in 1932 : 12.2 cwt. per acre.

0.2 cwt. N. applied in 1933 : 20.7 cwt. per acre.

These results indicate that the dung supplied produced the same increase in yield of green material as 0.118 cwt. N. per acre as sulphate of ammonia. The equivalence would be substantially the same if worked on the dry matter figures : in any case the accuracy of the dry matter determinations is undeterminable since bulked replicates were used.

There is no evidence of any residual effect of the sulphate of ammonia applied in 1932, nor of any interactions between the dung and the 1933 nitrogen.

SUGAR BEET

WOBURN

Effect of varying spacing of rows, of sulphate of ammonia and of ploughing or harrowing in mineral fertilisers.

W.S.—Lansome—1933
Plan and yields in lb.

Treat-ment.	Roots (dirty).	Tops	Sugar per cent.	Treat-ment.	Roots (dirty).	Tops	Sugar per cent.	Treat-ment.	Roots (dirty).	Tops	Sugar per cent.
19	-S ₁₅ Bh 319	165	17.15	N ₂ S ₂₀ Bp 360	235	17.04	37	-S ₁₀ Bp 370	239	16.78	
	N ₁ S ₁₅ Bp 432	222	17.32	-S ₁₀ Bp 400	227	18.37		N ₁ S ₂₀ Bp 309	218	16.75	
	N ₂ S ₂₀ Bp 371	223	16.89	N ₁ S ₁₅ Bp 434	244	17.79		N ₂ S ₂₀ Bh 314	250	16.06	
	-S ₁₀ Bp 394	236	17.47	N ₁ S ₁₀ Bh 486	299	18.11		-S ₁₅ Bh 333	208	17.38	
	N ₁ S ₂₀ Bh 393	212	17.04	-S ₂₀ Bh 340	222	17.12		N ₁ S ₁₀ Bh 437	303	17.79	
	N ₂ S ₁₀ Bh 564	323	17.62	N ₂ S ₁₅ Bh 467	267	17.30		N ₂ S ₁₅ Bp 370	286	16.78	
	N ₁ S ₂₀ Bp 391	216	17.24	N ₂ S ₁₀ Bp 511	310	17.93		-S ₁₅ Bp 214	191	17.30	
	N ₂ S ₁₅ Bh 508	255	17.36	-S ₁₅ Bp 337	192	18.48		N ₂ S ₁₀ Bh 401	317	17.53	
	-S ₁₅ Bp 341	177	17.33	N ₂ S ₂₀ Bh 395	258	17.41		N ₂ S ₂₀ Bp 309	222	16.84	
	N ₁ S ₁₀ Bh 570	262	17.36	-S ₁₀ Bh 466	232	17.96		N ₁ S ₁₀ Bp 440	268	17.80	
	N ₂ S ₁₀ Bp 572	345	17.67	N ₁ S ₂₀ Bp 373	240	17.50		-S ₂₀ Bh 272	173	17.59	
	-S ₂₀ Bh 377	195	17.36	N ₁ S ₁₅ Bh 444	236	17.44		N ₁ S ₁₅ Bh 318	237	17.73	
	N ₂ S ₁₅ Bp 512	267	17.30	N ₂ S ₁₀ Bh 496	285	17.40		N ₁ S ₁₅ Bp 340	231	17.70	
	-S ₁₀ Bh 469	248	18.02	N ₁ S ₂₀ Bh 340	203	17.53		N ₂ S ₁₅ Bh 410	273	17.56	
	N ₁ S ₁₅ Bh 416	241	17.88	N ₁ S ₁₀ Bp 456	218	17.82		-S ₁₀ Bh 330	222	17.88	
	N ₁ S ₁₀ Bp 521	233	17.88	-S ₂₀ Bp 310	187	18.25		-S ₂₀ Bp 263	170	17.73	
	-S ₂₀ Bp 305	149	17.79	N ₂ S ₁₅ Bp 429	291	17.64		N ₁ S ₂₀ Bh 327	211	17.24	
	N ₂ S ₂₀ Bh 335	196	16.52	-S ₁₅ Bh 307	151	17.56	54	N ₂ S ₁₀ Bp 535	326	17.62	

18 N ↑

55

72

N ₁	N ₁	N ₂	N ₁	N ₂	N ₁	N ₂	N ₁	N ₂	N ₁	N ₂	N ₁	N ₂
S ₁₅	S ₁₀	S ₁₅	S ₁₀	S ₁₅	S ₁₀	S ₁₅	S ₁₀	S ₁₅	S ₁₀	S ₁₅	S ₁₀	S ₁₅
Bh	Bp	Bh	Bp	Bh	Bp	Bh	Bp	Bh	Bp	Bh	Bp	Bh
435	354	452	423	475	408	415	368	459	424	424	443	264
200	200	246	185	301	232	291	291	262	296	215	249	264
17.88	17.74	17.62	17.82	17.44	17.99	17.47	17.47	18.37	17.47	18.05	17.85	17.36

SYSTEM OF REPLICATION : 12 randomised blocks of 6 plots each. Certain degrees of freedom for interactions are partially confounded with blocks.

AREA OF EACH PLOT (after rejecting edge rows) : 10 inch spacing : 0.01666 acre. 15 inch spacing : 0.01591 acre. 20 inch spacing : 0.01516 acres. Plots actually 15.15 links \times 120 links rows.

TREATMENTS : All combinations of :

- (a) Rows spaced 10 inches (S_{10}), 15 inches (S_{15}), and 20 inches (S_{20}) apart.
- (b) No sulphate of ammonia (-), sulphate of ammonia at the rate of 0.3 cwt. N per acre (N_1) and 0.6 cwt. N per acre (N_2).
- (c) Basal mineral fertilisers (superphosphate at the rate of 0.5 cwt. P_2O_5 per acre and 30% potash salt at the rate of 1.0 cwt. K_2O per acre) ploughed in (B_P) and harrowed in (B_H).

CULTIVATIONS, ETC. : Ploughed : May 1st-5th. Manures applied : May 10th. Seed sown : May 9th. Tractor cultivation : April 19th, 21st and May 8th. Harrowed : May 8th and 10th. Rolled : May 11th. Singled : June 9th. Plants 9 inches apart. Hoed : May 29th, June 15th and 20th, and September 1st-20th. Harvested : November 21st. Variety : Kuhn. Previous crop : Brussels sprouts.

STANDARD ERRORS PER PLOT : Roots : ± 0.753 tons per acre or $\pm 8.17\%$. Tops : ± 0.570 tons per acre or $\pm 8.54\%$. Sugar percentage : ± 0.284 . Mean dirt tare : 10 inch spacing : 0.1981, 15 inch spacing : 0.1954, 20 inch spacing : 0.1821.

SUMMARY OF RESULTS

Yields of Separate Treatments. (Block effects eliminated)

	Basal minerals ploughed under			Basal minerals harrowed in		
	Spacing of 10 ins.	Spacing of 15 ins.	Spacing of 20 ins.	Spacing of 10 ins.	Spacing of 15 ins.	Spacing of 20 ins.
ROOTS (washed)—tons per acre (± 0.478)*						
No Nitrogen	8.14	7.17	7.60	9.15	7.65	8.16
0.3 cwt. Nitrogen	10.28	9.04	8.34	10.71	9.25	9.30
0.6 cwt. Nitrogen	11.49	10.13	8.87	11.67	10.51	8.55
TOPS—tons per acre (± 0.360)*						
No Nitrogen	6.07	4.98	5.30	6.16	5.25	5.80
0.3 cwt. Nitrogen	6.48	6.50	6.57	7.18	6.72	6.47
0.6 cwt. Nitrogen	8.61	8.02	7.01	8.34	7.55	7.09
SUGAR PERCENTAGE (± 0.180)*						
No Nitrogen	17.74	17.73	17.89	17.79	17.63	17.36
0.3 cwt. Nitrogen	17.81	17.53	17.38	18.03	17.63	17.39
0.6 cwt. Nitrogen	17.64	17.41	17.05	17.66	17.37	16.90
TOTAL SUGAR—cwt. per acre.						
No Nitrogen	28.9	25.4	27.2	32.6	27.0	28.3
0.3 cwt. Nitrogen	36.6	31.7	29.0	38.6	30.8	32.3
0.6 cwt. Nitrogen	40.5	35.3	30.2	41.2	36.5	28.9

* For second order interactions only.

MAIN EFFECTS

Mean yields. Roots : 9.22 tons ; Tops : 6.67 tons ; Sugar Percentage : 17.55 ; Total Sugar : 32.4 cwt.

Spacing

	Roots (washed)		Tops		Sugar percentage		Total Sugar	
	Tons p.a.	Diff.	Tons p.a.	Diff.	Actual	Diff.	Cwt. p.a.	Diff.
10in. between rows	10.24	—	7.14	—	17.78	—	36.4	—
15 " " "	8.96	-1.28	6.50	-0.64	17.55	-0.23	31.4	-5.0
20 " " "	8.47	-0.49	6.38	-0.12	17.33	-0.22	29.3	-2.1
Standard Error	±0.154	±0.218	±0.117	±0.165	±0.058	±0.082	—	—

Basals

	Roots (washed)		Tops		Sugar percentage		Total Sugar	
	Tons p.a.	Diff.	Tons p.a.	Diff.	Actual	Diff.	Cwt. p.a.	Diff.
Basals ploughed in	9.01	—	6.61	—	17.58	—	31.7	—
" harrowed in	9.44	+0.43	6.73	+1.2	17.53	-0.05	33.1	+1.4
Standard Error	±0.126	±0.178	±0.095	±0.134	±0.047	±0.066	—	—

Nitrogen

	Roots (washed)		Tops		Sugar Percentage		Total Sugar	
	Tons p.a.	Diff.	Tons p.a.	Diff.	Actual	Diff.	Cwt. p.a.	Diff.
No Nitrogen ..	7.98	—	5.60	—	17.69	—	28.2	—
0.3 cwt. Nitrogen	9.49	+1.51	6.64	+1.04	17.62	-0.07	33.4	+5.2
0.6 cwt. Nitrogen	10.20	+0.71	7.78	+1.14	17.34	-0.28	35.4	+2.0
Standard Error	±0.154	±0.218	±0.117	±0.165	±0.058	±0.082	—	—

INTERACTION OF SPACINGS AND SULPHATE OF AMMONIA. MEAN OF BOTH BASALS

	Roots (washed)			Tops			Sugar Percentage			Total Sugar		
	Tons per acre			Tons per acre			(±0.107)			Cwt. per acre		
	(±0.285)			(±0.216)								
	Nitrogen			Nitrogen			Nitrogen			Nitrogen		
	None	0.3 cwt.	0.6 cwt.	None	0.3 cwt.	0.6 cwt.	None	0.3 cwt.	0.6 cwt.	None	0.3 cwt.	0.6 cwt.
10 in. Spacing	8.64	10.50	11.58	6.12	6.83	8.48	17.76	17.92	17.65	30.8	37.6	40.8
15 in. Spacing	7.41	9.15	10.32	5.12	6.61	7.78	17.68	17.58	17.39	26.2	32.1	35.9
20 in. Spacing	7.88	8.82	8.71	5.55	6.52	7.05	17.62	17.38	16.98	27.8	30.6	29.6

INTERACTION OF SPACINGS AND BASALS. MEAN OF ALL LEVELS OF NITROGEN

	Roots (washed) Tons per acre (± 0.218)		Tops Tons per acre (± 0.165)		Sugar Percentage (± 0.082)		Total Sugar Cwt. per acre	
	Basal minerals ploughed under	Basal minerals harrowed in	Basal minerals ploughed under	Basal minerals harrowed in	Basal minerals ploughed under	Basal minerals harrowed in	Basal minerals ploughed under	Basal minerals harrowed in
10 in. Spacing ..	9.97	10.51	7.05	7.23	17.73	17.83	35.3	37.5
15 in. Spacing ..	8.78	9.15	6.50	6.51	17.56	17.54	30.8	32.1
20 in. Spacing ..	8.27	8.67	6.30	6.45	17.44	17.22	28.8	29.8

INTERACTION OF NITROGEN AND BASALS. MEAN OF ALL SPACINGS

	Roots (washed) Tons per acre (± 0.218)		Tops Tons per acre (± 0.165)		Sugar Percentage (± 0.082)		Total Sugar Cwt. per acre.	
	Basal minerals ploughed under	Basal minerals harrowed in	Basal minerals ploughed under	Basal minerals harrowed in	Basal minerals ploughed under	Basal minerals harrowed in	Basal minerals ploughed under	Basal minerals harrowed in
No Nitrogen ..	7.64	8.32	5.45	5.74	17.79	17.59	27.2	29.3
0.3 cwt. Nitrogen	9.24	9.74	6.51	6.78	17.57	17.68	32.4	34.4
0.6 cwt. Nitrogen	10.14	10.27	7.88	7.67	17.37	17.31	35.3	35.5

CONCLUSIONS

The 10 inch spacing gives the greatest yields of both roots and tops and the highest sugar percentage, the yield of total sugar being 7.1 cwt. or 22 per cent greater on the 10 inch than on the 20 inch spacing.

Sulphate of ammonia significantly increases the yields of roots and tops, the response to the second dressing being significantly less in the case of the roots. The sugar percentage is significantly decreased, particularly by the second dressing, but the total sugar is increased by 5.2 cwt. or 16.0 per cent. by the single dressing and by 7.2 cwt. or 22 per cent. by the double dressing.

The nitrogen shows a significant interaction with spacing in the case of the roots, there being a considerably smaller response to nitrogen at the wider spacings.

Basals harrowed in give a significantly greater yield of roots than basals ploughed under. This is the opposite of the effect at Rothamsted.

BRUSSELS SPROUTS

WOBURN

Comparison of the effect of poultry manure with that of equivalent sulphate of ammonia and superphosphate.

WD—Lansome, 1933

Plan and yields in lb. Saleable Sprouts. (Total of all pickings).

SW ↑ 19	1	NP 48.81	NM 58.88	NM 50.43	O 40.26	N 47.37	P 37.25	6 24
	6	PM 46.11	O 38.62	PM 52.31	NP 49.62	NPM 46.87	M 46.94	
	19	M 40.49	NPM 61.55	P 32.36	NPM 48.49	PM 39.30	NM 49.93	
	24	P 32.75	N 55.07	M 51.94	N 53.86	O 39.23	NP 51.43	

SYSTEM OF REPLICATION : 6 randomised blocks of 4 plots each. Second order interaction confounded with block differences.

AREA OF EACH PLOT : 0.01033 acre. (5 yds. × 10 yds.)

TREATMENTS : All combinations of :

- (a) No poultry manure, and poultry manure at the rate of 0.6 cwt. N per acre with addition of superphosphate at the rate of 0.116 cwt. P₂O₅ per acre, to give a total of 0.6 cwt. P₂O₅ per acre (M).
- (b) No sulphate of ammonia, and sulphate of ammonia at the rate of 0.6 cwt. N per acre (N).
- (c) No superphosphate, and superphosphate at the rate of 0.6 cwt. P₂O₅ per acre (P).

BASAL MANURING : Muriate of potash at the rate of 1.0 cwt. K₂O per acre.

CULTIVATIONS, ETC. : Cultivated : May 29th. Hoed : August 2nd. Manures applied : June 27th. Planted : June 27th. Harvested : November 30th, January 3rd, and January 30th. Previous crop : Brussels sprouts.

STANDARD ERROR PER PLOT : Total of all pickings : 4.61 cwt. or 11.4 per cent.

INDIVIDUAL TREATMENTS

Saleable Sprouts—cwt. per acre.

Mean yield : 40.45 cwt.

Pickings	Sub-Blocks A				Sub-Blocks B			
	O	NM	NP	MP	N	P	M	NMP
1st	17.32	26.74	23.62	22.55	27.04	14.28	21.90	26.51
2nd	7.22	8.85	8.56	6.70	7.71	5.69	8.60	7.64
3rd	9.58	10.42	11.12	10.54	10.41	9.61	9.77	11.19
Total	34.12	46.01	43.30	39.79	45.16	29.58	40.27	45.34

INDIVIDUAL TREATMENTS—PERCENTAGE BLOWN TO TOTAL

Pickings	Sub-Blocks A				Sub-Blocks B			
	O	NM	NP	MP	N	P	M	NMP
1st ..	16.2	20.4	16.7	16.5	17.9	17.2	16.4	16.4
2nd ..	5.1	5.9	5.9	6.2	5.5	5.6	4.6	6.1
3rd ..	5.2	5.3	7.4	6.5	6.5	5.9	6.1	6.6

INDIVIDUAL TREATMENTS—PERCENTAGE FIRSTS TO SECONDS
 Firsts denote sprouts too large to pass through a 1¼ in. riddle (blown sprouts excluded).

Pickings	Sub-blocks A				Sub-blocks B			
	O	NM	NP	MP	N	P	M	NMP
1st	57.5	90.2	118.3	64.2	122.3	39.1	102.3	94.3
2nd	No Firsts in 2nd. and 3rd. pickings.							
3rd								

RESPONSES TO TREATMENTS

Saleable Sprouts—total of all pickings

Cwt. per acre	Mean Response	Differential Responses					
		Sulphate of Ammonia		Poultry Manure		Superphosphate	
		Absent	Present	Absent	Present	Absent	Present
Sulphate of Amm.	+9.01 ¹	—	—	+12.38 ²	+5.64 ²	+8.39 ²	+9.64 ²
Poultry Manure ..	+4.81 ¹	+8.18 ²	+1.44 ²	—	—	+3.50 ²	+6.12 ²
Superphosphate ..	-1.89 ¹	-2.51 ²	-1.26 ²	-3.20 ²	-0.58 ²	—	—

Standard Errors: (1) ±1.89, (2) ±2.67.

POULTRY MANURE, SULPHATE OF AMMONIA AND SUPERPHOSPHATE

Saleable Sprouts—total of all pickings

Cwt. per acre	Mean of P and no P (±1.89)		Mean of N and no N (±1.89)		
	No N	N	No P	P	Mean
No M. ..	31.85	44.23	39.64	36.44	38.04
M. ..	40.03	45.68	43.14	42.57	42.86
Mean . .	35.94	44.96	41.39	39.50	40.45

CONCLUSIONS

The total saleable sprouts show a significant response to poultry manure and to sulphate of ammonia, the responses to these two fertilisers not being significantly different. The percentage of firsts to seconds was significantly increased by sulphate of ammonia and by poultry manure, the increase due to sulphate of ammonia being significantly the greater, but there is no further increase when the two were applied together.

The superphosphate shows no significant effects on the total saleable sprouts, but significantly decreases the percentage of firsts to seconds in the first picking.