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## Report for 1934

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## Other Experiments at Rothamsted

### Rothamsted Research

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## WHEAT

### Effect of sulphate of ammonia applied at seven different times

RW—Long Hoos VII, 1934

Plan and sample weights in grammes, grain above, straw below

	<b>5</b>	<b>7</b>	<b>1</b>	<b>2</b>	<b>3</b>	<b>0</b>	<b>4</b>	<b>6</b>	
	1,552 2,693	1,870 2,579	1,716 2,998	1,695 2,474	1,667 2,465	1,604 2,141	1,483 2,020	1,435 2,060	
	<b>6</b>	<b>3</b>	<b>0</b>	<b>7</b>	<b>2</b>	<b>1</b>	<b>5</b>	<b>4</b>	
	1,408 2,154	1,879 3,026	1,821 2,666	1,727 2,339	1,797 2,585	1,696 2,298	1,698 2,236	1,588 2,270	
	<b>0</b>	<b>6</b>	<b>2</b>	<b>1</b>	<b>4</b>	<b>7</b>	<b>3</b>	<b>5</b>	
	1,778 2,825	1,701 2,561	1,587 2,407	1,663 2,732	1,636 2,626	1,454 2,072	1,536 2,137	1,883 2,569	
N ↑	<b>3</b>	<b>4</b>	<b>7</b>	<b>5</b>	<b>1</b>	<b>6</b>	<b>2</b>	<b>0</b>	
	1,816 2,848	1,730 2,990	1,595 2,492	1,814 2,653	1,585 2,332	1,894 2,617	2,077 2,769	1,134 1,786	
	<b>1</b>	<b>2</b>	<b>4</b>	<b>6</b>	<b>0</b>	<b>5</b>	<b>7</b>	<b>3</b>	
	1,634 2,411	1,909 2,987	1,834 3,098	1,794 2,833	1,387 2,015	1,472 2,067	1,693 2,270	1,609 2,425	
	<b>4</b>	<b>0</b>	<b>5</b>	<b>3</b>	<b>6</b>	<b>2</b>	<b>1</b>	<b>7</b>	
	1,801 2,668	1,579 2,674	1,838 2,858	1,944 3,034	1,530 2,099	1,578 2,640	1,688 2,640	1,798 2,851	
	<b>7</b>	<b>1</b>	<b>6</b>	<b>4</b>	<b>5</b>	<b>3</b>	<b>0</b>	<b>2</b>	
	1,917 2,954	1,776 2,637	1,753 2,484	1,567 2,508	1,685 3,031	1,879 2,601	1,715 2,399	1,780 2,726	
	<b>2</b>	<b>5</b>	<b>3</b>	<b>0</b>	<b>7</b>	<b>4</b>	<b>6</b>	<b>1</b>	
	1,641 2,504	1,661 2,438	1,519 1,561	1,856 2,694	1,885 2,689	1,728 2,566	1,329 1,894	1,870 2,840	

SYSTEM OF REPLICATION : 8 × 8 Latin square.  
 AREA OF EACH PLOT : 0.01928 acre (30 ft. × 28 ft.).  
 TREATMENTS : No sulphate of ammonia (O) and sulphate of ammonia at the rate of 0.3 cwt. N per acre, applied on October 12 (1), December 7 (2), January 18 (3), March 1 (4), April 12 (5), May 10 (6), and June 7 (7).  
 CULTIVATIONS, ETC. : Ploughed : September 26-30. Harrowed : October 10. Seed sown : October 12. Harrowed : April 7. Rolled : April 16. Harvested : August 6. Plots harvested by sampling method (24 metre lengths per plot, drills set 6 ins. apart). Variety : Victor. Previous crop : Beans.  
 STANDARD ERRORS PER PLOT : Grain : 3.94 cwt. per acre or 10.7%. Straw : 7.07 cwt. per acre or 12.9%.

#### Summary of results : cwt. per acre

	No N	Oct. 12	Dec. 7	Jan. 18	Mar. 1	Apr. 12	May 10	June 7	Mean of all N	St. error
GRAIN (±1.39) ..	35.0	37.1	38.3	37.7	36.4	37.0	35.0	37.9	37.1	±0.525
Increase (±1.97)		+2.1	+3.3	+2.7	+1.4	+2.0	0.0	+2.9		
STRAW (±2.50) ..	52.3	56.9	57.4	54.7	56.5	55.9	50.9	55.1	55.3	±0.945
Increase (±3.54)		+4.6	+5.1	+2.4	+4.2	+3.6	-1.4	+2.8		

#### Conclusions

The average increase due to sulphate of ammonia is not significant, nor is there any evidence that the effect varies with time of application.

## POTATOES

Effect of time of ploughing and dung application  
Comparison of fresh and rotted dung  
Effect of sulphate of ammonia

RP—Long Hoos III, 1934

Plan and yields in lb.

55	—	F	ASL	208	28	—	F	ASL	224	1	—	—	ASE	178
	N <sub>2</sub>	—	SL	168		N <sub>1</sub>	R	ASL	274		N <sub>1</sub>	R	SL	233
	N <sub>1</sub>	F	SL	247		N <sub>2</sub>	—	ASL	248		N <sub>2</sub>	—	SL	235
	N <sub>2</sub>	R	ASL	249		N <sub>1</sub>	—	SL	219		N <sub>2</sub>	R	ASE	256
	N <sub>1</sub>	R	ASE	264		N <sub>2</sub>	R	ASE	292		N <sub>1</sub>	F	ASE	282
	N <sub>2</sub>	F	ASE	295		—	R	SL	233		—	R	ASL	241
	N <sub>1</sub>	—	ASL	232		N <sub>1</sub>	F	ASE	269		N <sub>2</sub>	F	ASL	260
	—	R	SL	251		N <sub>2</sub>	F	SL	238		N <sub>1</sub>	—	ASL	209
	—	—	ASE	205		—	—	ASE	200		—	F	SL	235
	N <sub>2</sub>	R	ASE	306		N <sub>1</sub>	F	ASL	282		N <sub>2</sub>	F	ASE	304
	—	F	ASE	237		N <sub>2</sub>	R	ASL	296		N <sub>1</sub>	—	ASE	221
	—	R	ASL	243		N <sub>2</sub>	—	SL	251		N <sub>2</sub>	—	ASL	239
—	—	SL	188	N <sub>1</sub>	—	ASE	231	—	R	ASE	238			
N <sub>2</sub>	—	ASL	262	N <sub>2</sub>	F	ASE	303	N <sub>1</sub>	F	SL	288			
N <sub>1</sub>	—	ASE	249	—	F	SL	263	—	F	ASL	254			
N <sub>1</sub>	F	ASL	341	N <sub>1</sub>	R	SL	301	N <sub>1</sub>	R	ASL	280			
N <sub>2</sub>	F	SL	325	—	—	ASL	241	N <sub>2</sub>	R	SL	308			
N <sub>1</sub>	R	SL	317	—	R	ASE	298	—	—	SL	200			
N <sub>2</sub>	—	ASE	233	N <sub>2</sub>	—	ASE	251	—	R	SL	245			
N <sub>2</sub>	R	SL	284	N <sub>1</sub>	F	SL	269	N <sub>2</sub>	F	SL	265			
N <sub>1</sub>	F	ASE	278	N <sub>1</sub>	—	ASL	220	—	—	ASL	191			
—	F	SL	252	—	F	ASE	252	N <sub>1</sub>	F	ASL	296			
N <sub>1</sub>	R	ASL	292	—	R	ASL	257	—	F	ASE	250			
—	—	ASL	197	N <sub>1</sub>	R	ASE	280	N <sub>2</sub>	—	ASE	249			
—	R	ASE	259	N <sub>2</sub>	F	ASL	312	N <sub>1</sub>	—	SL	245			
N <sub>1</sub>	—	SL	251	N <sub>2</sub>	R	SL	297	N <sub>2</sub>	R	ASL	313			
N <sub>2</sub>	F	ASL	300	—	—	SL	204	N <sub>1</sub>	R	ASE	292			
81				54				27						

→ Bouts

SYSTEM OF REPLICATION : 9 randomised blocks of 9 plots each. Certain high order interactions partially confounded with block differences.

AREA OF EACH PLOT : 1/100th acre (95.2 lks. × 17.5 lks., 5 rows per plot, of which the 3 middle rows were harvested).

TREATMENTS : All combinations of :

- Land ploughed in autumn and spring, dung applied in autumn (ASE), ploughed in autumn and spring, dung in spring (ASL) and ploughed in spring, dung in spring (SL).
- No dung (—), 20 tons per acre fresh dung (F) and rotted dung derived from 20 tons of fresh dung (R).
- No sulphate of ammonia (—), sulphate of ammonia at the rate of 0.4 cwt. N per acre (N<sub>1</sub>) and 0.8 cwt. N per acre (N<sub>2</sub>).

BASAL MANURING : 0.5 cwt. P<sub>2</sub>O<sub>5</sub> per acre as superphosphate and 1.0 cwt. K<sub>2</sub>O per acre as sulphate of potash.

CULTIVATIONS, ETC. : Autumn fresh and rotted dung applied : November 22. Autumn ploughed : November 24-25. Spring rotted dung applied : April 10. Spring fresh dung applied : April 12. Spring ploughed : April 13-14. Disc harrowed : April 19. Tooth harrowed : April 19. Rotted : April 25. Ridged : April 28 and 30. Artificials applied : April 30 and May 1. Potatoes planted : May 1-2. Harrowed : May 19. Grubbed : May 28, June 6 and July 6. Earthed up : June 18 and July 10. Lifted : October 12, 13 and 15. Variety : Ally. Previous crop : Oats.

STANDARD ERROR PER PLOT : 0.824 tons per acre, or 7.21 %.

**Yields of separate treatments (block effects eliminated) : tons per acre**

Times of ploughing	Dung applied	No dung			Fresh dung			Rotted dung		
		Sulph.amm.(cwt.N)			Sulph.amm.(cwt.N)			Sulph.amm.(cwt.N)		
		0.0	0.4	0.8	0.0	0.4	0.8	0.0	0.4	0.8
Autumn & spring	{ Autumn Spring	9.28	10.06	10.85	10.47	12.88	13.41	11.54	12.56	12.88
Spring		8.30	10.80	10.08	11.23	12.10	12.11	11.29	12.37	13.09

**Main effects and interaction of dung and sulphate of ammonia, tons per acre ( $\pm 0.275$ )**

Sulphate of Ammonia	None	Dung Fresh	Rotted	Mean ( $\pm 0.159$ )	Increase ( $\pm 0.225$ )
0.0 cwt. N .. ..	8.95	10.79	11.24	10.32	
0.4 cwt. N .. ..	10.30	12.66	12.56	11.84	+1.52
0.8 cwt. N .. ..	10.60	12.91	12.90	12.14	+0.30
Mean ( $\pm 0.159$ ) ..	9.95	12.12	12.23	11.43	
Increase ( $\pm 0.225$ ) ..		+2.17	+2.28		

**Main effects of times of ploughing and interaction with dung, tons per acre ( $\pm 0.275$ )**

Times of Ploughing	Dung applied	No dung	Fresh	Dung Rotted	Mean of dung ( $\pm 0.194$ )
Autumn and Spring ..	{ Autumn Spring Spring	10.06 <sup>1</sup>	12.25	12.33	12.29
Spring .. ..			12.29	12.13	12.21
Spring .. ..		9.73	11.82	12.25	12.04

<sup>1</sup> Standard error :  $\pm 0.194$ .

**Interaction of times of ploughing with sulphate of ammonia, tons per acre**

Times of ploughing	Sulphate of Ammonia			Standard error
	0.0 cwt. N	0.4 cwt. N	0.8 cwt. N	
Autumn and spring	10.35	11.88	12.32	$\pm 0.194$
Spring .. ..	10.27	11.76	11.76	$\pm 0.275$

**Conclusions**

There was a significant increase of 1.52 tons per acre to the first dressing (0.4 cwt. N per acre) of sulphate of ammonia. The small additional increase of 0.30 tons per acre to the second dressing was not significant and was significantly less than the response to the first dressing. The dressing of dung (20 tons per acre) gave a significant increase of 2.23 tons per acre, but there was no difference in effect of fresh and rotted dung, or of the autumn and spring applications. The additional ploughing in autumn had little effect either in the presence or absence of dung, the weighted mean of the increases due to it being 0.23 tons per acre with a standard error of  $\pm 0.213$ .

## SUGAR BEET

Effect of spring ploughing in addition to autumn ploughing, of potassium and sodium chlorides applied before spring ploughing and at sowing, and of intensive inter-row cultivation.

RS—LONG HOOS 1, 1934

Plan and yields in lb.

		Roots	Tops	Sugar	Plant			Roots	Tops	Sugar	Plant		
		(dirty)		per	num-			(dirty)		per	num-		
				cent.	ber					cent.	ber		
32	S — — L —	605	582	17.48	466								
	— — NA LC	542	525	17.25	500								
	S K — EC	577	508	17.74	466								
	S K NA L —	610	554	17.89	451								
	— K — LC	539	475	17.86	460								
	— K NA E —	631	490	17.94	496								
	— — — E —	568	418	18.45	469								
	S — NA EC	533	411	17.71	444								
	— K NA L —	662	535	18.12	506								
	S — — E —	562	492	17.05	455								
	— — — L —	621	502	17.80	479								
	S — NA LC	597	552	17.14	494								
	S K NA E —	656	538	17.94	458								
	S K — LC	608	582	16.93	467								
	— — NA EC	585	532	17.51	468								
	— K — EC	561	510	17.86	488								
	— K — E —	632	544	17.94	487								
	— K NA LC	542	451	17.16	456								
	S K — L —	566	454	18.12	473								
	S — — EC	524	390	17.14	435								
	S — NA L —	608	482	17.68	479								
	— — NA E —	499	546	18.06	462								
	— — — LC	514	453	17.48	424								
	S K NA EC	555	447	18.20	434								
	— — NA L —	499	438	17.48	401								
	S K — E —	558	417	17.97	436								
	— — — EC	524	386	17.77	421								
	— K — L —	579	435	18.35	400								
	— K NA EC	500	430	17.71	451								
	S — NA E —	587	494	17.71	435								
	S — — LC	483	454	17.71	408								
1	S K NA LC	535	550	17.14	456								
	— — — E —	566	551	16.73	471								
	— — NA LC	581	518	17.74	438								
	S — — L C	527	474	17.57	414								
	— K NA L —	777	440	17.86	455								
	S K — L —	616	486	17.86	431								
	S — NA E —	630	478	18.06	470								
	— K — EC	555	473	17.86	435								
	S K NA EC	596	512	17.48	461								
	— — — LC	545	535	17.34	422								
	S K NA L —	672	584	17.40	429								
	— — NA E —	610	462	17.89	446								
	— K NA EC	553	469	17.63	471								
	S — — E —	648	478	17.92	474								
	— K — L —	667	581	17.84	482								
	S K — EC	632	538	17.37	492								
	S — NA LC	610	541	17.40	458								
	S — NA EC	547	466	17.74	517								
	— K — E —	600	499	17.02	484								
	S K — LC	516	458	17.40	517								
	— K NA LC	551	480	17.97	502								
	S K NA E —	564	456	18.32	517								
	— — — EC	486	430	17.08	511								
	S — — L —	565	538	17.42	478								
	— — NA L —	555	526	17.94	492								
	— K NA E —	534	416	18.58	468								
	S K — E —	545	402	18.35	467								
	— — NA EC	351	358	18.00	485								
	— — — L —	553	446	18.32	469								
	S K NA LC	369	488	18.46	477								
	S — NA L —	684	458	17.89	478								
	— K — LC	471	385	17.60	493								
	S — — EC	500	379	17.74	465								

**SYSTEM OF REPLICATION :** 8 randomised blocks of 8 plots each. Certain interactions are partially confounded with block differences.

**AREA OF EACH PLOT :** 0.015 acre after rejecting edge rows. Plots actually 12.6 links  $\times$  198.4 links rows.

**TREATMENTS :** All combinations of :

$$\left\{ \begin{array}{l} \text{Not spring ploughed (—)} \\ \text{Spring Ploughed (S)} \end{array} \right\} \times \left\{ \begin{array}{l} \text{No potassium chloride (—)} \\ \text{Potassium Chl. (0.75 cwt. Cl) (K)} \end{array} \right\} \times \left\{ \begin{array}{l} \text{No sodium chloride (—)} \\ \text{Sodium chloride (0.75} \\ \text{cwt. Cl) (Na)} \end{array} \right\} \\ \times \left\{ \begin{array}{l} \text{Minerals applied early (E)} \\ \text{Minerals applied late (L)} \end{array} \right\} \times \left\{ \begin{array}{l} \text{Ordinary cultivation (—)} \\ \text{Intensive cultivation (C)} \end{array} \right\}$$

**BASAL MANURING :** 0.5 cwt.  $P_2O_5$  as superphosphate and 0.6 cwt. N as sulphate of ammonia, per acre.

**CULTIVATIONS, ETC. :** Ploughed : November 4th-7th. Early manures applied : March 28th. Spring ploughed : April 3rd-4th. Drag-harrowed : April 24th. Cultivated with tractor : May 2nd. Late manures applied : May 8th. Harrowed : May 9th. Rolled : May 10th. Seed sown : May 10th. Harrowed : May 12th. Rolled : May 15th. Hoed : June 4th. Singled : June 29th-July 3rd. Plants 10 inches apart. Motor-hoed (intensive cultivation plots) : July 7th, 17th and 27th, August 8th, 18th and 31st. Hoed : July 31st. Lifted : November 16th-27th. Variety : Kleinwanzleben E. Previous crop : Spring oats.

**STANDARD ERRORS PER PLOT :** Roots (washed) : 1.07 tons per acre or 6.99%. Tops : 1.24 tons per acre or 8.64%. Sugar percentage : 0.385. Plant number : 1.35 thousands per acre or 4.38%. Mean dirt tare : 0.0909.

### Yields of Separate Treatments (block effects eliminated)

#### ROOTS washed—tons per acre

	No potassium chloride				Potassium chloride			
	No sodium chloride		Sodium Chloride		No sodium chloride		Sodium chloride	
	Ordinary cultivation.	Intensive cultivation.	Ordinary cultivation.	Intensive cultivation.	Ordinary cultivation.	Intensive cultivation.	Ordinary cultivation.	Intensive cultivation.
Not spring ploughed— Minerals early Minerals late	15.58	14.03	14.60 14.73	13.20 14.58	17.47 16.13	14.08 14.61	16.71 18.45	13.52 15.59
Spring ploughed— Minerals early Minerals late ..	15.59	14.26	16.03 18.93	14.91 15.02	16.05 15.88	15.45 15.10	16.40 16.44	15.46 13.35

### Responses to Treatments

MEAN YIELDS: Roots (washed): 15.36 tons; Tops: 14.36 tons; Sugar percentage: 17.72; Total sugar: 54.5 cwt.; Plant number: 30.9 thousands.

	Mean response	Differential responses							
		Potassium chloride		Sodium chloride		Spring ploughing		Cultivation	
		Absent	Present	Absent	Present	Absent	Present	Ordinary	Intensive
ROOTS (washed) : tons per acre ( $\pm 0.379$ . Means: $\pm 0.268$ )									
Potassium chloride	+0.61	—	—	+0.73	+0.49	+1.28	-0.06	+0.86	+0.36
Sodium chloride	+0.26	+0.38	+0.14	—	—	-0.02	+0.54	+0.55	-0.03
Spring ploughing	+0.36	+1.03	-0.31	+0.09	+0.64	—	—	+0.21	+0.52
Intensive cultivation ..	-1.79	-1.54	-2.04	-1.50	-2.08	-1.95	-1.63	—	—
TOPS : tons per acre ( $\pm 0.438$ . Means: $\pm 0.310$ )									
Potassium chloride	+0.27	—	—	+0.45	+0.10	-0.02	+0.57	-0.11	+0.66
Sodium chloride	+0.34	+0.52	+0.17	—	—	-0.01	+0.70	+0.13	+0.56
Spring ploughing	+0.38	+0.08	+0.67	+0.02	+0.73	—	—	+0.12	+0.64
Intensive cultivation ..	-0.53	-0.94	-0.14	-0.73	-0.31	-0.78	-0.26	—	—
SUGAR PERCENTAGE ( $\pm 0.136$ . Means: $\pm 0.096$ )									
Potassium chloride	+0.18	—	—	+0.19	+0.16	+0.15	+0.20	+0.23	+0.13
Sodium chloride	+0.12	+0.14	+0.10	—	—	+0.10	+0.14	+0.13	+0.11
Spring ploughing	-0.07	-0.10	-0.04	-0.09	-0.05	—	—	-0.08	-0.06
Intensive cultivation ..	-0.27	-0.22	-0.32	-0.26	-0.28	-0.28	-0.26	—	—
TOTAL SUGAR : cwt. per acre									
Potassium chloride	+2.7	—	—	+3.1	+2.3	+5.0	+0.4	+3.8	+1.6
Sodium chloride	+1.3	+1.7	+0.9	—	—	+0.3	+2.4	+2.4	+0.2
Spring ploughing	+1.1	+3.4	-1.2	0.0	+2.1	—	—	+0.5	+1.7
Intensive cultivation ..	-7.2	-6.1	-8.3	-6.1	-8.3	-7.8	-6.6	—	—
PLANT NUMBER : thousands per acre ( $\pm 0.478$ . Means: $\pm 0.338$ )									
Potassium chloride	+0.5	—	—	+0.9	+0.1	+0.7	+0.3	0.0	+0.9
Sodium chloride	+0.4	+0.9	-0.1	—	—	+0.4	+0.4	+0.1	+0.8
Spring ploughing	-0.2	0.0	-0.4	-0.2	-0.2	—	—	-0.3	-0.1
Intensive cultivation ..	-0.1	-0.5	+0.4	-0.4	+0.3	-0.2	0.0	—	—

**Main Effects and Interactions of Times of Application of Minerals**

Minerals applied	No spring Ploughing	Spring ploughing	Ordinary cultivation	Intensive cultivation	Sodium chloride	Potassium chloride	Both chlorides	Mean	Increase
ROOTS (washed) : tons per acre									
Early	14.81	15.58	15.88	14.51	14.68	15.76	15.52	15.32	
Late ..	15.56	15.51	16.64	14.42	15.82	15.43	15.96	15.74	+ 0.42
St. error	±0.268			±0.379				±0.219	±0.310
TOPS : tons per acre									
Early	13.98	13.78	14.29	13.46	13.94	14.48	13.98	14.13	
Late ..	14.37	15.32	14.96	14.73	15.03	14.34	15.19	14.85	+ 0.72
St. error	±0.310			±0.438				±0.253	±0.358
SUGAR PERCENTAGE									
Early	17.74	17.78	17.87	17.66	17.84	17.76	17.98	17.86	
Late ..	17.77	17.59	17.84	17.51	17.56	17.74	17.75	17.68	- 0.18
St. error	±0.096			±0.136				±0.078	±0.111
TOTAL SUGAR : cwt. per acre									
Early	52.5	55.4	56.8	51.2	52.4	56.0	55.8	54.7	
Late ..	55.3	54.6	59.4	50.5	55.6	54.7	56.7	55.7	+ 1.0
PLANT NUMBER : thousands per acre.									
Early	31.2	31.0	31.2	31.0	31.0	31.3	31.3	31.2	
Late ..	30.8	30.7	30.7	30.8	31.2	31.0	31.1	31.1	- 0.1
St. error	±0.338			±0.478				±0.276	±0.390

In the above table, the effects of early and late application of minerals have been estimated as straight means over the plots receiving NaCl, KCl and both chlorides. The interactions of the effect of time of application with spring ploughing and intensive cultivation are partially confounded with blocks. In showing these effects in the above tables the method of adjustment for block differences has been to include the plots receiving neither chloride. To estimate the interactions, the values obtained by the usual process should therefore be multiplied by four-thirds.

**Conclusions**

Potassium chloride gave a significant increase in the roots and an almost significant increase in sugar percentage. Both increases were quite small, however, the corresponding increase in total sugar being 2.7 cwt. per acre or 5 per cent. The interaction between potassium chloride and the additional spring ploughing was significant, spring ploughing having apparently nullified any increase given by potassium chloride. This effect, however, appeared only in a small group of plots—those receiving sodium chloride applied late—so that its reality is doubtful.

There were no significant responses to sodium chloride.

The application of manures at sowing instead of before the spring ploughing significantly decreased the sugar percentage but produced very little difference in the yield of total sugar.

The additional spring ploughing had no effect.

Intensive cultivation proved much inferior to ordinary, giving significant decreases in both roots and sugar percentage. The resultant decrease in total sugar was 7.2 cwt. per acre or 12 per cent.



## SUGAR BEET

Effect of spacing of rows, of application of sulphate of ammonia and dung, and of additional heavy rolling of the seed-bed.

RS—LONG HOOS I, 1934

Plan and yields in lb.

		Roots	Tops	Sugar	Plant			Roots	Tops	Sugar	Plant					
		(dirty)	(dirty)	per	num-	(dirty)	(dirty)	(dirty)	(dirty)	per	num-	(dirty)	(dirty)			
		cent.				ber	cent.				ber					
88	S <sub>15</sub> N D —	427	492	16.99	548	S <sub>15</sub> N D —	475	450	16.82	589	112	S <sub>15</sub> N D —	475	450	16.82	589
	S <sub>20</sub> — D R	408	294	17.05	419	S <sub>20</sub> N — —	426	351	16.93	373		S <sub>20</sub> N — —	426	351	16.93	373
	S <sub>10</sub> N — —	494	453	16.39	1,051	S <sub>10</sub> N — R	490	408	16.88	1,019		S <sub>10</sub> N — R	490	408	16.88	1,019
	S <sub>15</sub> N — R	424	364	17.08	632	S <sub>20</sub> — — R	339	198	17.17	370		S <sub>20</sub> — — R	339	198	17.17	370
	S <sub>20</sub> — — —	376	231	17.02	410	S <sub>15</sub> N — R	445	372	17.54	591		S <sub>15</sub> N — R	445	372	17.54	591
	S <sub>10</sub> — — R	423	319	17.17	1,082	S <sub>10</sub> — D R	467	378	17.05	1,052		S <sub>10</sub> — D R	467	378	17.05	1,052
	S <sub>15</sub> — D R	446	322	17.42	634	S <sub>15</sub> — D R	486	322	17.22	583		S <sub>15</sub> — D R	486	322	17.22	583
	S <sub>20</sub> N — R	419	326	16.36	384	S <sub>15</sub> — — —	424	248	17.17	536		S <sub>15</sub> — — —	424	248	17.17	536
	S <sub>10</sub> — D —	501	404	17.17	1,072	S <sub>20</sub> N D R	470	446	17.02	370		S <sub>20</sub> N D R	470	446	17.02	370
	S <sub>15</sub> — — —	472	320	17.34	589	S <sub>10</sub> N D —	669	625	16.65	1,017		S <sub>10</sub> N D —	669	625	16.65	1,017
	S <sub>10</sub> N D R	602	558	16.68	1,083	S <sub>20</sub> — D —	489	298	17.37	364		S <sub>20</sub> — D —	489	298	17.37	364
	S <sub>20</sub> N D —	448	424	16.65	401	S <sub>10</sub> — — —	543	353	17.14	987		S <sub>10</sub> — — —	543	353	17.14	987
65	S <sub>15</sub> — D —	427	302	17.11	626	S <sub>20</sub> — — —	435	256	18.00	366	89	S <sub>20</sub> — — —	435	256	18.00	366
	S <sub>10</sub> N — R	504	407	17.28	1,041	S <sub>20</sub> N D —	553	424	17.17	365		S <sub>20</sub> N D —	553	424	17.17	365
	S <sub>20</sub> — — R	416	184	16.53	403	S <sub>15</sub> — — R	491	276	17.66	587		S <sub>15</sub> — — R	491	276	17.66	587
	S <sub>20</sub> N D R	494	402	16.27	384	S <sub>15</sub> — D —	542	344	17.42	589		S <sub>15</sub> — D —	542	344	17.42	589
	S <sub>15</sub> N D R	503	418	17.11	617	S <sub>10</sub> N D R	627	483	17.02	1,134		S <sub>10</sub> N D R	627	483	17.02	1,134
	S <sub>10</sub> N D —	511	435	16.73	1,013	S <sub>10</sub> — — R	470	282	17.42	1,137		S <sub>10</sub> — — R	470	282	17.42	1,137
	S <sub>10</sub> — D R	406	298	17.17	1,059	S <sub>20</sub> — D R	465	233	17.40	584		S <sub>20</sub> — D R	465	233	17.40	584
	S <sub>20</sub> — D —	376	200	16.73	373	S <sub>10</sub> — D —	566	322	16.91	1,046		S <sub>10</sub> — D —	566	322	16.91	1,046
	S <sub>15</sub> N — —	450	352	16.73	542	S <sub>15</sub> N D R	564	413	17.25	580		S <sub>15</sub> N D R	564	413	17.25	580
	S <sub>10</sub> — — —	462	294	17.34	969	S <sub>10</sub> N — —	641	468	16.96	957		S <sub>10</sub> N — —	641	468	16.96	957
	S <sub>15</sub> — — R	324	178	17.76	525	S <sub>15</sub> N — —	534	348	16.73	498		S <sub>15</sub> N — —	534	348	16.73	498
	S <sub>20</sub> N — —	381	332	16.27	324	S <sub>20</sub> N — R	529	438	17.00	346		S <sub>20</sub> N — R	529	438	17.00	346

SYSTEM OF REPLICATION : 4 randomised blocks of 12 plots each. Certain high order interactions are partially confounded with block differences.

AREA OF EACH PLOT (after rejecting edge rows) : 10 inch spacing : 0.01515 acre ; 15 inch spacing : 0.01364 acre ; 20 inch spacing : 0.01212 acre. Plots actually 15.2 lks. x 120 lks. rows.

TREATMENTS : All combinations of :

$$\left\{ \begin{array}{l} 10 \text{ inch spacing (S}_{10}\text{)} \\ 15 \text{ inch spacing (S}_{15}\text{)} \\ 20 \text{ inch spacing (S}_{20}\text{)} \end{array} \right\} \times \left\{ \begin{array}{l} \text{No sulph. amm.} \\ \text{Sulph. Amm.} \\ \text{(0.6 cwt. N) (N)} \end{array} \right\} \times \left\{ \begin{array}{l} \text{No additional} \\ \text{heavy rolling.} \\ \text{Additional} \\ \text{heavy rolling(R)} \end{array} \right\} \times \left\{ \begin{array}{l} \text{No dung (—)} \\ \text{10 tons dung} \\ \text{(D)} \end{array} \right\}$$

BASAL MANURING : 1.0 cwt. K<sub>2</sub>O per acre as 30% potash manure salt and 0.5 cwt. P<sub>2</sub>O<sub>5</sub> as superphosphate.

CULTIVATIONS, ETC. : Dung and basal manures applied : Feb. 14. Ploughed : Feb. 15-16. Sulphate of ammonia applied : May 8. Harrowed : May 9. Seed sown : May 14. Harrowed : May 14. Rolled : May 15. Horse-hoed (wide rows) : June 2. Singled : July 3-11. Plants 10 ins. apart. Hoed : July 31. Lifted : Nov. 28-Dec. 7. Variety : Kleinwanzleben E. Previous crop : Spring oats.

STANDARD ERRORS PER PLOT : Roots (washed) : 1.10 tons per acre or 7.86%. Tops : 1.23 tons per acre or 10.6%. Sugar percentage : 0.281. Plant number : 2.95 thousands per acre or 6.15%. Mean dirt tare : 0.1005.

**Yields of Separate Treatments (block effects eliminated)**

**ROOTS (washed) : tons per acre**

Spacing	No sulphate of ammonia.				Sulphate of ammonia.			
	No additional heavy rolling.		Additional heavy rolling.		No additional heavy rolling.		Additional heavy rolling.	
	No dung.	Dung.	No dung.	Dung.	No dung.	Dung.	No dung.	Dung.
10 inches ..	13.81	13.65	11.34	12.06	14.55	16.13	13.66	15.80
15 inches ..	13.47	13.99	11.72	14.00	14.21	13.56	13.08	15.43
20 inches ..	12.82	14.94	13.12	13.85	13.98	15.97	15.09	16.58

**Responses to Treatments**

MEAN YIELDS : Roots (washed) : 14.03 tons ; Tops : 11.62 tons ; Sugar percentage : 17.05 ; Total sugar : 47.8 cwt. ; Plant number : 47.9 thousands.

	Mean response.	Differential responses.								
		Sulphate of ammonia.		Additional rolling.		Dung.		Spacing (inches).		
		Ab-sent.	Pre-sent.	Ab-sent.	Pre-sent.	Ab-sent.	Pre-sent.	10	15	20
<b>ROOTS (washed)—tons per acre</b>										
Sulphate of Ammonia .. ..	+ 1.61	—	—	+ 0.96	+ 2.26	+ 1.38	+ 1.83	+ 2.32	+ 0.78	+ 1.72
Additional rolling .. ..	- 0.45	- 1.10	+ 0.20	—	—	- 0.80	- 0.09	- 1.32	- 0.25	+ 0.23
Dung .. ..	+ 1.26	+ 1.04	+ 1.48	+ 0.90	+ 1.62	—	—	+ 1.07	+ 1.12	+ 1.58
Standard errors	± 0.318	± 0.450						± 0.550		
<b>TOPS—tons per acre</b>										
Sulphate of Ammonia .. ..	+ 4.60	—	—	+ 4.34	+ 4.86	+ 4.10	+ 5.10	+ 4.38	+ 3.67	+ 5.76
Additional rolling .. ..	- 0.53	- 0.79	- 0.26	—	—	- 0.66	- 0.39	- 0.82	- 0.78	+ 0.02
Dung .. ..	+ 2.08	+ 1.59	+ 2.58	+ 1.95	+ 2.22	—	—	+ 1.92	+ 2.47	+ 1.86
Standard errors	± 0.355	± 0.502						± 0.615		
<b>SUGAR PERCENTAGE</b>										
Sulphate of Ammonia .. ..	- 0.38	—	—	- 0.46	- 0.30	- 0.46	- 0.30	- 0.35	- 0.36	- 0.45
Additional rolling .. ..	+ 0.11	+ 0.02	+ 0.20	—	—	+ 0.15	+ 0.08	+ 0.17	+ 0.34	- 0.17
Dung .. ..	- 0.06	- 0.14	+ 0.02	- 0.03	- 0.10	—	—	- 0.15	- 0.09	+ 0.04
Standard errors	± 0.081	± 0.115						± 0.140		
<b>TOTAL SUGAR—cwt. per acre</b>										
Sulphate of Ammonia .. ..	+ 4.4	—	—	+ 1.9	+ 6.8	+ 3.4	+ 5.3	+ 6.9	+ 1.7	+ 4.5
Additional heavy rolling .. ..	- 1.2	- 3.7	+ 1.2	—	—	- 2.4	- 0.2	- 4.0	0.0	+ 0.3
Dung .. ..	+ 4.1	+ 3.2	+ 5.1	+ 3.0	+ 5.2	—	—	+ 3.2	+ 3.8	+ 5.5
<b>PLANT NUMBER—thousands per acre</b>										
Sulphate of Ammonia .. ..	- 1.6	—	—	- 1.5	- 1.8	- 1.2	- 2.0	- 0.7	- 0.7	- 3.5
Additional heavy rolling .. ..	+ 3.0	+ 3.2	+ 2.9	—	—	+ 3.0	+ 3.1	+ 4.1	+ 2.1	+ 2.9
Dung .. ..	+ 2.4	+ 2.8	+ 2.1	+ 2.4	+ 2.5	—	—	+ 2.0	+ 2.5	+ 2.9
Standard errors..	± 0.852	± 1.20						± 1.48		

### Main Effects and Interactions of Spacing

Spacing	Mean Response	Sulphate of Ammonia		Additional rolling		Dung		
		Absent	Present	Absent	Present	Absent	Present	
ROOTS (washed) : tons per acre ( $\pm 0.389$ . Means: $\pm 0.275$ )								
10 inches	13.87	12.71	15.03	14.53	13.21	13.34	14.40	
15 inches	13.68	13.30	14.07	13.81	13.56	13.12	14.24	
20 inches	14.54	13.68	15.40	14.43	14.66	13.75	15.34	
TOPS : tons per acre ( $\pm 0.436$ . Means: $\pm 0.308$ )								
10 inches	11.95	9.76	14.13	12.35	11.54	10.99	12.90	
15 inches	11.30	9.46	13.13	11.69	10.91	10.06	12.53	
20 inches	11.60	8.72	14.47	11.58	11.61	10.66	12.53	
SUGAR PERCENTAGE ( $\pm 0.099$ . Means: $\pm 0.070$ )								
10 inches	17.00	17.17	16.82	16.91	17.08	17.07	16.92	
15 inches	17.21	17.39	17.03	17.04	17.38	17.25	17.17	
20 inches	16.93	17.16	16.71	17.02	16.85	16.91	16.96	
TOTAL SUGAR : cwt. per acre								
10 inches	47.1	43.6	50.6	49.1	45.2	45.5	48.7	
15 inches	47.0	46.3	47.9	47.1	47.1	45.3	48.9	
20 inches	49.2	46.9	51.5	49.1	49.4	46.5	52.0	
PLANT NUMBER : thousands per acre ( $\pm 1.04$ . Means: $\pm 0.738$ )								
10 inches	69.0	69.3	68.6	66.9	71.0	68.0	69.9	
15 inches	42.5	42.8	42.1	41.4	43.5	41.3	43.7	
20 inches	32.2	33.9	30.4	30.7	33.6	30.7	33.6	

### Conclusions

The variation of spacing produced no significant results in roots, tops or sugar percentage.

Sulphate of ammonia significantly increased the yields of roots and tops and significantly decreased the sugar percentage, the net result being an increase in total sugar by 4.4 cwt. per acre or 10 per cent.

The dressing of dung also gave significant increases in roots and tops, but had no appreciable effect on sugar percentage. The increase in total sugar was 4.1 cwt. per acre or 9 per cent.

The additional heavy rolling produced small but not significant decreases in the yields of roots and tops.

Plant number was significantly raised by the dung and the heavy rolling.

There was a significant interaction in roots between sulphate of ammonia and rolling, the increase due to sulphate of ammonia being significantly greater with the additional heavy rolling than without. This effect also shows up strongly in total sugar, the increase due to sulphate of ammonia being 6.8 cwt. per acre with the additional heavy rolling, as against 1.9 cwt. without.

## BRUSSEL SPROUTS

Effect of sulphate of ammonia, poultry manure, soot and rape dust

FOSTER'S—RD, 1934

Plan and yields in lb. saleable sprouts

Total of all Pickings.

1	R <sub>1</sub> 235	O 213	O 216	M <sub>1</sub> 273	M <sub>2</sub> 268	R <sub>1</sub> 243	R <sub>2</sub> 240	N <sub>1</sub> 243	8
	O 214	S <sub>1</sub> 238	N <sub>1</sub> 237	M <sub>2</sub> 243	S <sub>2</sub> 240	M <sub>1</sub> 255	O 204	O 220	
SW ↑	R <sub>2</sub> 237	S <sub>2</sub> 245	O 237	N <sub>2</sub> 251	O 255	O 250	N <sub>2</sub> 260	S <sub>1</sub> 246	
	R <sub>2</sub> 257	O 258	M <sub>1</sub> 254	S <sub>1</sub> 266	R <sub>2</sub> 263	O 234	R <sub>1</sub> 240	M <sub>1</sub> 253	
	N <sub>2</sub> 266	O 266	M <sub>2</sub> 256	S <sub>2</sub> 254	M <sub>2</sub> 259	O 249	N <sub>1</sub> 265	O 227	
41	R <sub>1</sub> 260	O 248	O 228	N <sub>1</sub> 235	S <sub>2</sub> 248	N <sub>2</sub> 270	S <sub>1</sub> 250	O 236	48

SYSTEM OF REPLICATION : 4 randomised blocks of 12 plots each.

AREA OF EACH PLOT (after rejecting edge rows) : 0.024174 acre. Plots actually 10 yds. × 14 yds.

TREATMENTS : No nitrogen (O), sulphate of ammonia (N) half applied in seed bed and remainder as a top dressing, poultry manure (M), soot (S) and rape dust (R), applied at the rate of 0.4 cwt. N per acre (1) or 0.8 cwt. N per acre (2).

BASAL MANURING : Superphosphate at the rate of 1.0 cwt. P<sub>2</sub>O<sub>5</sub> and muriate of potash at the rate of 1.0 cwt. K<sub>2</sub>O per acre. (An allowance was made for the P<sub>2</sub>O<sub>5</sub> contained in the organic manures.)

CULTIVATIONS, ETC. : Ploughed : Apr. 6 and 7. Cultivated with tractor : May 23. Manures applied (sulphate of ammonia at half-rate) : May 23 and 24. Harrowed : May 25 and 26. Rolled : May 26. Brussels planted : June 8. Horse hoed : July 12 and 13. Hand hoed : July 17. Second half of sulphate of ammonia applied : July 28. Horse hoed : Aug. 8, 9 and 13. Hand hoed : Aug. 14. Harvested : First picking : Oct. 24, 25 and 29. Second picking : Dec. 18-20. Third picking : Feb. 13 and 14. Previous crop : Wheat.

STANDARD ERRORS PER PLOT total of all pickings (saleable sprouts) : 4.67 cwt. per acre or 5.14% ; first picking (saleable sprouts) : 4.02 cwt. per acre or 19.4%.

**INDIVIDUAL TREATMENTS**

Saleable sprouts : cwt per acre

Mean yield : 90.8 cwt.

Pickings	O	N <sub>1</sub>	N <sub>2</sub>	M <sub>1</sub>	M <sub>2</sub>	S <sub>1</sub>	S <sub>2</sub>	R <sub>1</sub>	R <sub>2</sub>
1st ..	20.6	21.4	21.4	22.7	19.8	22.3	19.4	21.1	18.2
2nd ..	47.7	50.5	55.9	53.3	55.7	50.4	52.5	51.1	55.9
3rd ..	18.3	18.6	19.5	19.6	19.3	19.6	19.3	18.1	17.9
Total ..	86.6	90.5	96.8	95.6	94.8	92.3	91.2	90.3	92.0

**Saleable Sprouts — total of all pickings : cwt. per acre**

Nitrogen, cwt. p.a.	Sulph. amm.	Poultry manure.	Soot.	Rape dust.	Mean.	Increase.
0.0					86.6 <sup>1</sup>	
0.4	90.5 <sup>3</sup>	95.6 <sup>3</sup>	92.3 <sup>3</sup>	90.3 <sup>3</sup>	92.2 <sup>1</sup>	+ 5.6 <sup>2</sup>
0.8	96.8 <sup>3</sup>	94.8 <sup>3</sup>	91.2 <sup>3</sup>	92.0 <sup>3</sup>	93.7 <sup>1</sup>	+ 1.5 <sup>2</sup>
Mean ..	93.6 <sup>2</sup>	95.2 <sup>2</sup>	91.7 <sup>2</sup>	91.2 <sup>2</sup>	90.8	
Difference		+ 1.6 <sup>3</sup>	- 1.9 <sup>3</sup>	- 2.4 <sup>3</sup>		

STANDARD ERRORS : (1) ±1.16, (2) ±1.64, (3) ±2.33.

**CONCLUSIONS**

There was a significant response to nitrogen in the total yield of all three pickings, the double dressing (0.8 cwt. N per acre) giving an increase of 7.1 cwt. per acre. The falling-off in response at the higher level of manuring, though striking, was not in itself significant.

There were no significant differences between the effects of the four qualities of nitrogen.

None of the treatments had a significant effect on the yields of the first picking, but it is worth noting that for three of the four types of nitrogen, the yield from the double dressing in the first picking was below that from the single, while for the fourth (sulphate of ammonia) the two were equal.

## BEANS

### Effect of dung, nitro-chalk and muriate of potash

RE—Long Hoos I, 1934

Plan and yields in lb., grain above, straw below

N ↑	1	$D_2N_2K_1$	$D_1N_2K_2$	$D_1N_1K_0$	$D_2N_2K_2$	$D_2N_0K_1$	$D_0N_0K_0$	$D_0N_0K_1$	$D_2N_2K_0$	$D_2N_0K_2$	9
		31.6 25.6	40.1 32.6	39.9 33.1	43.6 33.6	37.5 32.0	35.2 29.6	33.3 27.2	39.2 32.8	38.6 33.2	
		$D_1N_0K_1$	$D_2N_1K_2$	$D_2N_0K_0$	$D_0N_2K_1$	$D_2N_1K_0$	$D_0N_1K_2$	$D_0N_1K_0$	$D_1N_2K_1$	$D_1N_0K_0$	
		29.2 24.3	40.3 30.0	39.5 28.5	34.6 25.9	35.2 28.0	38.5 29.0	29.0 22.0	35.4 28.1	36.4 30.4	
		$D_0N_0K_2$	$D_0N_2K_0$	$D_0N_1K_1$	$D_1N_0K_2$	$D_1N_2K_0$	$D_1N_1K_1$	$D_0N_2K_2$	$D_1N_1K_2$	$D_2N_1K_1$	
		21.9 18.4	29.5 23.5	31.0 25.2	34.0 27.0	34.1 27.6	35.0 27.2	35.8 26.7	34.0 27.2	32.1 25.6	27

SYSTEM OF REPLICATION : 3 randomised blocks of 9 plots each, with two degrees of freedom, representing second order interactions, confounded with block differences. Error estimated from high order interactions,

AREA OF EACH PLOT : 1/60th acre (52.1 lks. × 32 lks.).

TREATMENTS : All combinations of :

- (a) No dung ( $D_0$ ), and dung at the rate of  $7\frac{1}{2}$  tons per acre ( $D_1$ ) and 15 tons per acre ( $D_2$ ).
- (b) No nitro-chalk ( $N_0$ ), and nitro-chalk at the rates of 0.2 cwt. N per acre ( $N_1$ ) and 0.4 cwt. N per acre ( $N_2$ ).
- (c) No muriate of potash ( $K_0$ ), and muriate of potash at the rates of 0.5 cwt.  $K_2O$  per acre ( $K_1$ ) and 1.0 cwt.  $K_2O$  per acre ( $K_2$ ).

BASAL MANURING : Superphosphate at the rate of 0.5 cwt.  $P_2O_5$  per acre.

CULTIVATIONS, ETC. : Dung applied : October 18. Ploughed : October 18-19. Rolled : October 20. Harrowed : October 24. Seed sown : October 24. Muriate of potash applied : October 25. Harrowed : October 25. Crop failed. Harrowed : February 9. Seed resown : February 9. Harrowed : February 10. Nitro-chalk applied : April 10. Horse-hoed : May 7, 8, 14, 25, 29 and 30. Hand-hoed : May 25, 29 and 30. Harvested : August 3. Previous crop : Oats.

STANDARD ERRORS PER PLOT : Grain : 1.94 cwt. per acre, or 10.4%. Straw : 1.65 cwt. per acre, or 11.0%.

N

**Main effects. Interactions of nitro-chalk with dung and potash**

Nitro-chalk	Dung : tons per acre			Potash : cwt. K <sub>2</sub> O per acre			Mean	Increase
	0	7½	15	0.0	0.5	1.0		
GRAIN : cwt. per acre ( $\pm 1.12$ . Means : $\pm 0.647$ . Increases : $\pm 0.915$ )								
0.0 cwt. N ..	16.1	17.8	20.6	19.8	17.8	16.9	18.2	
0.2 cwt. N ..	17.6	19.4	19.2	18.6	17.5	20.1	18.7	+0.5
0.4 cwt. N ..	17.8	19.6	20.4	18.4	18.1	21.3	19.3	+0.6
Mean .. ..	17.2	18.9	20.1	18.9	17.8	19.4	18.7	
Increase .. ..		+1.7	+1.2		-1.1	+1.6		
STRAW : cwt. per acre ( $\pm 0.951$ . Means : $\pm 0.549$ . Increases : $\pm 0.776$ )								
0.0 cwt. N ..	13.4	14.6	16.7	15.8	14.9	14.0	14.9	
0.2 cwt. N ..	13.6	15.6	14.9	14.8	13.9	15.4	14.7	-0.2
0.4 cwt. N ..	13.6	15.8	16.4	15.0	14.2	16.6	15.3	+0.6
Mean .. ..	13.5	15.3	16.0	15.2	14.3	15.3	15.0	
Increase .. ..		+1.8	+0.7		-0.9	+1.0		

**Interaction of potash and dung**

Potash	GRAIN : cwt. per acre			STRAW : cwt. per acre		
	Dung : tons per acre			Dung : tons per acre		
	0	7½	15	0	7½	15
0.0 cwt. K <sub>2</sub> O	16.7	19.7	20.3	13.4	16.3	15.9
0.5 cwt. K <sub>2</sub> O	17.7	17.8	18.1	14.0	14.2	14.8
1.0 cwt. K <sub>2</sub> O	17.2	19.3	21.9	13.2	15.5	17.3

**Conclusions**

There is a significant response to dung both in grain and in straw, the response, in grain to the first 7½ tons of dung being 1.7 cwt., or 10.0 %, and to the second 7½ tons 1.2 cwt., or 6.3%. The responses to the second dressing are smaller than the responses to the first, but not significantly so. The response to nitro-chalk is not significant, and there is no sign of response to potash. There is, however, a positive interaction, significant in the case of grain, between potash and nitro-chalk.