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Experiments at Woburn

Rothamsted Research

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WOBURN.

Barley : Effect of fertilisers on yield and quality.

Butt Close, 1928.

S.

A								B								
N	N	N	O	N	K	K	P	O	N	K	K	N	N	P	N	K
K	P			K	P			K	P	P		P				

C								D							
N	O	N	N	N	K	K	K	O	K	N	N	N	P	K	N
K			P	P	P				P	P	K	P	P		

SYSTEM OF REPLICATION : 4 randomised blocks of 8 plots each.

Area of plot : $\frac{1}{10}$ acre.

TREATMENTS :

O=No manure.

Sulphate of Ammonia (N) at the rate of 1 cwt. per acre ; Sulphate of Potash (K) at the rate of $1\frac{1}{2}$ cwt. per acre, and Superphosphate (P) at the rate of 3 cwt. per acre, in all combinations.

Manures applied April 19.

Barley sown, March 17 ; Harvested August 9.

VARIETY : "Spratt Archer."

Actual Weights in lb.—Total Grain.

Block.	O	P	N	K	NP	KP	NK	NKP
A	43.25	37.25	61.25	78.75	55.5	43.25	67.25	31.25
B	34.0	61.25	48.0	57.0	38.75	66.0	64.0	57.25
C	42.0	41.5	47.0	55.75	43.75	44.0	45.25	42.5
D	23.25	52.25	77.75	53.75	60.5	59.75	46.5	53.25

Actual Weights in lb.—Total Straw.

Block.	O	P	N	K	NP	KP	NK	NKP
A	59.75	54.0	86.0	93.25	80.75	56.0	94.5	44.75
B	45.75	62.0	55.75	60.75	54.5	79.5	81.0	71.0
C	67.0	52.75	75.5	73.75	70.75	59.0	77.75	65.0
D	40.25	55.5	80.0	68.5	86.0	63.75	54.0	68.5

Summary of Results.

Average Yield.	No Manure.	Super.	S/Amm.	S/Potash	S/Amm. + Super.	S/Potash + Super.	S/Am. + S/Potash	S/Am. + S/Potash + Super.	Mean.	Standard Error.
Grain, cwts. per acre ...	12.7	17.2	20.9	21.9	17.7	19.0	19.9	16.5	18.2	2.05
Grain, per cent. ...	69.8	94.2	114.7	120.2	97.3	104.4	109.3	90.3	100.0	11.26
Straw, cwts. per acre ...	19.0	20.0	26.5	26.5	26.1	23.1	27.4	22.3	23.9	2.31
Straw, per cent. ...	79.6	83.9	111.3	110.9	109.3	96.7	115.0	93.3	100.0	9.69
Per cent. Nitrogen in dry matter of grain ...	1.316	1.296	1.340	1.387	1.398	1.328	1.346	1.372	1.348	0.036

Significant interaction of the nitrogenous and potassic fertilisers. In the absence of one the other increased the yield significantly, but in the presence of one there was no effect due to the adding of the other. With straw there was a direct significant response to Sulphate of Ammonia.

WOBURN.

Potatoes : Nitrogenous Fertilisers, Sulphate of Ammonia and Cyanamide, each in single and double dressings.

Lansome, 1926.

I	2C	1S	1C	0	2S
II	1S	1C	2C	2S	0
III	2S	2C	0	1C	1S
IV	0	2S	1S	2C	1C
V	1C	0	2S	1S	2C

VARIETY : King Edward.

SYSTEM OF REPLICATION : Latin Square.

Area of each plot 28 ft. × 31 ft. = $\frac{1}{80}$ acre.

TREATMENTS :

0 : Control.

1S : 1 cwt. Sulphate of Ammonia per acre.

2S : 2 cwt. Sulphate of Ammonia per acre.

1C : Single Cyanamide = 1 cwt. S/Amm.

2C : Double Cyanamide = 2 cwt. S/Amm.

All plots had a basal dressing of Farmyard Manure, Sulphate of Potash and Superphosphate, applied with S/Amm. in the bouts on May 10 ; 2C applied April 23 ; 1C on April 30. Dung carted and spread May 3-8.

Potatoes planted May 10-12 ; lifted October 11-12.

Actual Yields in lb.

Rows.	0	1C	1S	2C	2S
I	293	368	370	380	387
II	322	331	320	354	334
III	268	332	321	359	370
IV	292	298	322	347	347
V	282	298	321	295	322

Summary of Results.

Average Yield.	No Nitrogen.	Single Cyanamide	Single Sulphate.	Double Cyanamide	Double Sulphate.	Mean.	Standard Error.
Tons per acre	6.50	7.26	7.38	7.75	7.86	7.35	0.20
Per cent. ...	88.5	98.8	100.4	105.4	106.9	100.0	2.71

Significant response to nitrogen in both single and double dressings. The difference between Sulphate and Cyanamide is insignificant.

WOBURN.

Potatoes : Nitrogenous Fertilisers, Sulphate of Ammonia, Urea, Cyanamide, each in single and double dressings.

Lansome, 1927.

N.W.					
A			B		
0(a)	1U	2S	0(a)	0(b)	2C
2U	1C	1S	0(c)	2U	2S
2C	0(b)	0(c)	1C	1S	1U
1S	2S	1U	2U	2C	0(a)
2U	2C	0(a)	1U	1C	1S
1C	0(b)	0(c)	2S	0(b)	0(c)
C			D		

VARIETY : King Edward.
 SYSTEM OF REPLICATION : 4 randomised blocks.
 Area of Plots : $\frac{1}{10}$ acre.
 0 = Control.
 1-2 = Nitrogen at the rate of $1\frac{1}{2}$ and 3 cwts. per acre, Sulphate of Ammonia or its equivalent, applied May 19-20.
 S = Sulphate of Ammonia.
 C = Cyanamide.
 U = Urea.
 All plots had basal dressing of 3 cwt. Super and 2 cwt. Mur/Pot. per acre applied May 19-20; also 10 tons dung per acre, applied May 9-13.
 Potatoes planted May 23; lifted October 12-18.

Actual Yields in lb.

Block.	0(a)	0(b)	0(c)	1U	1C	1S	2U	2C	2S
A	410	432	411	436	426	399	407	424	362
B	361	361	369	374	376	436	382	352	332
C	372	361	338	399	380	456	381	371	418
D	355	327	289	376	362	315	383	361	329

Summary of Results.

Average Yield.	O	Single Urea.	Single Cyanamide	Single Sulphate.	Double Urea.	Double Cyanamide	Double Sulphate.	Mean.	Standard Error.
Tons per acre	6.53	7.08	6.89	7.17	6.93	6.73	6.43	6.76	0.249
Per cent. ...	96.6	104.7	102.0	106.1	102.6	99.6	95.2	100.0	3.69

Significant response to single dressing of Nitrogen. The double dressing of Urea and Cyanamide produced no further increase, while that of Sulphate of Ammonia reduced the yield.

WOBURN.

Potatoes : Nitrogenous Fertilisers, Sulphate of Ammonia, Cyanamide (each with and without nitrate of soda), Nitrophoska, Compound " B."

Stackyard, 1928.

N.W.

A

15	16	2	13	9	10	1	17	5	12	4	8	3	6	14	11	18	7
----	----	---	----	---	----	---	----	---	----	---	---	---	---	----	----	----	---

B

17	3	14	13	18	11	6	15	2	1	10	12	7	8	5	9	4	6
----	---	----	----	----	----	---	----	---	---	----	----	---	---	---	---	---	---

C

6	10	3	2	18	7	12	9	1	5	15	4	11	8	13	17	16	14
---	----	---	---	----	---	----	---	---	---	----	---	----	---	----	----	----	----

D

17	3	14	1	6	16	15	5	12	9	4	2	7	8	13	11	18	10
----	---	----	---	---	----	----	---	----	---	---	---	---	---	----	----	----	----

VARIETY : Majestic. Block A sown with " Ally."
 SYSTEM OF REPLICATION : 4 randomised blocks of 18 plots each.
 AREA OF PLOT : $\frac{1}{40}$ acre.
 TREATMENTS : Compound Fertiliser " B" and Nitrophoska equivalent to $1\frac{1}{2}$ cwt. per acre Sulphate of Ammonia ; Sulphate of Ammonia and Cyanamide with and without Nitrate of Soda at the rate of $1\frac{1}{2}$ cwt. S/Amm. or equivalent, together with Sulphate of Potash and Superphosphate* to raise to equivalence with compound fertilisers.

KEY TO TREATMENTS.

NITROGEN = $1\frac{1}{2}$ cwt. S/Amm. Others in cwt. per acre

Treatment.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
Nitrogen	"B"	Nitro-phoska.	Cyana-mide.	$\frac{3}{4}$ Cyanam. Nit/Soda	Sulphate of Amm.	$\frac{3}{4}$ S/Amm. Nit/Soda	"B"	Nitro-phoska.	No Nitrogen.									
Potash ... Phosphate	-	-	$\frac{1}{4}$	2	$1\frac{1}{2}$	2	$1\frac{1}{2}$	2	$1\frac{1}{2}$	2	$1\frac{1}{2}$	-	-	$\frac{1}{4}$	2	2	$1\frac{1}{2}$	$1\frac{1}{2}$
Calcium Sulphate												=2P	=1 $\frac{1}{2}$ P	=2P				

Plots 12 to 14 had Calcium Sulphate added equivalent to that in 2 and $1\frac{1}{2}$ cwt. Superphosphate as shown.
 * Plots 16 and 18 had Phosphate in the form of Potassium Phosphate equivalent to that in Superphosphate.
 All plots had 14 tons F.Y.M. per acre. Artificial manures applied May 5-9.
 Potatoes planted May 5-9 ; lifted October 24-26.

Actual Weights in lb.

Block.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
A	782	724	754	654	743	773	744	845	744	805	766	783	762	702	610	688	634	531
B	850	827	812	645	686	754	769	804	804	757	836	860	821	771	704	565	663	759
C	840	874	834	793	779	697	807	830	757	833	809	808	695	688	685	648	771	775
D	755	783	744	687	706	761	779	771	762	676	694	771	647	731	714	699	624	576
Average, tons per acre	14.4	14.3	14.0	12.4	13.0	13.3	13.8	14.5	13.7	13.7	13.9	14.4	13.1	12.9	12.1	11.6	12.0	11.8

Summary of Significant Results.

Average Yield.	With Potash and Phosphate equivalent to compound fertilisers.									Mean.	Standard Error(b).
	No Nitrogen.	Nitro-phoska.	Standard Error(a).	Comp'nd "B."	Sulphate of Amm.	S/Am.+ Nit/Soda.	Cyana-mide.	Cyana.+ Nit/Soda.			
Tons per acre	11.88	13.58	0.24	14.40	14.10	13.79	12.71	13.58	13.28	0.33	
Per cent.	89.5	102.3	1.77	108.4	106.2	103.4	95.7	102.3	100.0	2.51	

(a) Refers to means of 16 plots.
 (b) Refers to means of 8 plots.

Significant response to Nitrogen except where Cyanamide was the only Nitrogenous Manure applied. No significant differences between the other nitrogenous fertilisers, or between the plots receiving Phosphate as a Calcium Salt and in other forms.

WOBURN.

Sugar Beet : (a) Comparison of Nitrogenous Fertilisers : Sulphate and Muriate of Ammonia and Cyanamide.

(b) Preparation of Seed Bed.

Butt Close, 1927.

S.S.W.

R	F	R	F	R	F	R	F	R	F	R	F	R	F	R	F	R	F
2S	0C	0S	1S	1M	2C	0C	1S	1M	2C	2S	0M	2C	1S	0S	2M	1M	0M
0C	1C	1S	2M	2C	0M	1S	2M	2C	0S	0M	1C	1S	0C	2M	1C	0M	2S
1C	2S	2M	0S	0M	1M	2M	0C	0S	1M	1C	2S	0C	2C	1C	0S	2S	1M
A						B						C					

QUANTITIES : Nitrogen at the rate of 0, 1, 2 cwt. per acre Sulphate of Ammonia or equivalent.

SYSTEM OF REPLICATION : 3 randomised blocks of 18 plots each.

S = Sulphate of Ammonia.

M = Muriate of Ammonia.

C = Cyanamide.

R, F = Alternative Strips with ridged and flat seed bed.

AREA OF EACH PLOT : $\frac{1}{10}$ acre.

Seed sown June 16. Pulled Jan. 5-13, 1928.

All plots received 3 cwt. Super. and 2 cwt. Muriate of Potash per acre, applied with other manures June 10-14. Dung applied February 22-24 (14 loads per acre). Ground chalk April 6 (1 ton per acre).

Actual weights in lb.

Blocks.	0C	0S	0M	1C	1S	1M	2C	2S	2M
ROOTS.									
A { R	100.5	67.5	90.0	95.0	79.0	79.0	114.5	125.0	95.5
F	100.5	114.5	119.5	127.0	91.0	145.5	99.5	123.5	133.0
B { R	68.0	95.0	101.0	129.5	104.0	92.0	114.0	109.0	124.5
F	101.5	147.0	148.5	163.5	102.0	143.5	154.5	156.0	126.5
C { R	126.5	135.5	162.0	150.5	131.5	134.5	136.0	171.0	184.0
F	166.0	121.5	129.5	184.5	186.0	157.0	155.5	192.5	191.0
TOPS.									
A { R	185.0	117.0	164.0	170.0	125.0	131.0	216.0	241.0	192.0
F	195.0	226.0	218.0	243.0	167.0	286.0	176.0	236.0	276.0
B { R	115.0	131.0	163.0	199.5	157.0	140.0	163.0	175.5	206.0
F	132.0	229.0	245.0	294.0	179.0	228.0	299.5	262.0	216.0
C { R	181.0	238.0	274.0	211.0	243.0	217.0	234.0	255.0	262.0
F	250.0	196.0	251.0	270.0	295.5	255.0	250.0	350.0	305.0

(1) Summary of Results, Manuring Experiment.

ROOTS.

Quantity of Nitrogen.	Average Yield in Tons per acre.			Average Yield per cent.		
	Cyanamide.	Sulphate.	Muriate.	Cyanamide.	Sulphate.	Muriate.
0		2.60			91.1	
1	3.16	2.58	2.80	110.9	90.5	98.1
2	2.88	3.26	3.18	101.0	114.5	111.5
Standard Error	0.16			5.60		

TOPS.

Quantity of Nitrogen.	Average Yield in tons per acre.			Average Yield per cent.		
	Cyanamide.	Sulphate.	Muriate.	Cyanamide.	Sulphate.	Muriate.
0		4.35			90.5	
1	5.16	4.34	4.68	107.3	90.2	97.2
2	4.98	5.65	5.42	103.5	117.5	112.7
Standard Error	0.34			7.02		

(2) Summary of Results, Cultivation Experiment.

Average Yield.	Ridged.	Flat.	Mean.	Standard Error.
Roots, tons per acre	2.57	3.13	2.85	0.08
Roots, per cent. ...	90.3	109.7	100.0	2.77
Tops, tons per acre	4.22	5.40	4.81	0.17
Tops, per cent. ...	87.8	112.2	100.0	3.44

Well marked superiority of flat over ridged seed bed. Significant response to both single and double Nitrogen except in the case of the Sulphate plots (single dressing), while with Cyanamide there was a depression in yield with the higher dressing.

**WOBURN.
SUGAR BEET.**

Nitrogenous Fertilisers : Sulphate of Ammonia } Each applied
 Muriate of Ammonia } with seed.
 Nitrochalk as top dressing.
Potassic Fertilisers : Muriate of Potash.
 Potash Manure Salts.
Nitrophoska.

Butt Furlong, 1928.

S.

A	12	9	2	4	13	5	3	8	7	1	6	10	11
B	6	7	12	4	13	1	3	10	5	2	8	9	11
C	6	2	12	3	4	8	7	11	1	10	5	9	13
D	9	4	12	2	13	5	11	10	6	7	3	8	1
E	12	5	10	3	13	7	8	6	1	2	4	9	11
F	1	8	2	6	9	12	10	5	4	13	11	7	3

VARIETY : Dippe.
 SYSTEM OF REPLICATION : 6 randomised blocks of 13 plots each.
 Area of each plot : $\frac{1}{10}$ acre.
 TREATMENTS : Sulphate and Muriate of Ammonia alone at the rate of $1\frac{1}{2}$ cwt. S/Amm. per acre or equivalent, also at half this rate combined with equivalent Nitrochalk as Top Dressing. Muriate of Potash and Potash Manure Salts at the rate of 1 cwt. per acre M/Pot. or equivalent. Superphosphate at the rate of $1\frac{1}{2}$ cwt. per acre. Nitrophoska equivalent to $1\frac{1}{2}$ cwt. S/Amm. Basal Manure : 12 tons F.Y.M. per acre March 30-April 4. Artificial Manures applied May 22-23, except top dressing, which was applied July 5.
 Seed sown, May 18 ; Roots lifted November 8-13.

Key to Treatments.

Manure.		1	2	3	4	5	6	7	8	9	10	11	12	13
Potash = 1 cwt. M/Pot. Nitrogen = $1\frac{1}{2}$ cwt. S/Am.	S/Amm. ...	×		×		×		×		×		×		
	M/Amm. ...		×		×		×		×		×		×	
	Nitro-chalk			×	×			×	×			×	×	
	M/Pot. ...	×	×	×	×									
	P.M.S. ...					×	×	×	×					
Super at $1\frac{1}{2}$ cwt.	×	×	×	×	×	×	×	×	×	×	×	×	×	
Nitrophoska ...														×

Actual Weights in lb.—Roots.

Block.	1	2	3	4	5	6	7	8	9	10	11	12	13
A	799	861	799	885	785	760	812	820	930	761	789	901	901
B	735	763	649	861	654	881	890	729	726	623	726	881	864
C	772	912	828	861	784	830	811	841	701	735	737	895	757
D	689	911	746	873	880	803	759	752	817	802	872	890	902
E	739	713	957	720	869	717	871	881	708	879	730	911	952
F	806	891	699	764	738	881	663	924	800	815	781	833	764

Actual Weights in lb.—Tops.

Block.	1	2	3	4	5	6	7	8	9	10	11	12	13
A	706	879	640	840	630	669	820	741	803	679	629	799	848
B	638	535	398	734	421	651	680	521	476	419	570	741	698
C	602	747	937	931	631	859	733	992	565	557	594	883	678
D	552	850	615	710	875	582	631	643	711	610	792	810	859
E	647	667	733	682	622	651	863	863	672	647	683	655	786
F	546	563	729	768	755	736	716	591	710	778	829	797	812

(1) Summary of Average Yields, Separate Treatments.

	Yield in tons per acre.	Sulphate of Ammonia.		Muriate of Ammonia.		Nitro-phoska.
		Top Dressing.	No Top Dressing.	Top Dressing.	No Top Dressing.	
Roots	Muriate of Potash	13.92	13.51	14.77	15.03	} 15.30
	Potash Manure Salts	14.30	14.02	14.72	14.50	
	No Potash ...	13.79	13.93	15.81	13.74	
Tops	Muriate of Potash...	12.06	10.99	13.88	12.62	} 13.93
	Potash Manure Salts	13.22	11.71	12.95	12.35	
	No Potash ...	12.19	11.72	13.94	10.98	
Sugar percentage in roots	Muriate of Potash...	18.37	17.80	17.85	17.68	} 17.63
	Potash Manure Salts	17.60	18.43	17.72	17.98	
	No Potash ...	18.70	17.97	17.72	18.33	

(2) Summary of Significant Results.

Average Yield.	Sulphate Amm.	Muriate Amm.	Sulphate+Nitrochalk.	Muriate+Nitrochalk.	Standard Error (a).	Nitro-phoska.	Standard Error (b).	Mean.
†Roots, tons per acre	13.82	14.42	14.00	15.10	0.32	15.30	0.55	14.41
Roots, per cent. ...	95.9	100.1	97.2	104.8	2.20	106.2	3.80	100.0
Tops, tons per acre	11.47	11.98	12.49	13.59	0.45	13.93	0.77	12.50
Tops, per cent. ...	91.8	95.8	99.9	108.7	3.56	111.4	6.17	109.0
Sugar percentage ...	18.07	18.00	18.22	17.76	0.18	17.63	0.31*	17.96

(a) Refers to means of 18 plots.

(b) Refers to means of 6 plots.

* From 45 plots only.

† Roots weighed dirty. Approximately 20% should be subtracted for tare.

Muriate of Ammonia beats Sulphate of Ammonia significantly, while the response to top dressing is significant only in the case of tops. Nitrophoska plots appear to be better than the plots receiving all Nitrogen as basal. No significant differences in sugar content and no response to potash.

WOBURN : OTHER EXPERIMENTS.

Mangolds and Potatoes : Nitrogenous Fertilisers, Sulphate of Ammonia and Muriate of Ammonia (one half at sowing, one half as top dressing), Muriate of Potash.

Mangolds, Warren Field. Potatoes, Lansome Field, 1926.

All plots received 9 tons F.Y.M. and 2 cwt. superphosphate per acre. Plots 1, 2 and 3 had in addition a basal dressing of 1 cwt. Sulphate of Potash, while Plots 4 and 5 had 2 cwt. Sulphate of Ammonia (one half at sowing, one half as top dressing). Area of each plot $\frac{1}{4}$ acre.

Plot Number	1	2	3	4	5
Additional Manuring per acre.	Muriate of Amm. equiv. to 2 cwt. S/Amm. $\frac{1}{2}$ sowing, $\frac{1}{2}$ top dressing.	No Nitrogen.	2 cwt. Sulphate of Ammonia, $\frac{1}{2}$ sowing, $\frac{1}{2}$ top dressing	No Potash.	Muriate of Potash equiv. to 1 cwt. Sulphate of Potash
Produce in { Mangolds tons per acre { Potatoes	23.28 6.19	17.96 5.38	21.8 6.07	23.49 5.61	23.91 6.30

Mangolds : Top Dressings, Sulphate of Ammonia, Nitrate of Soda, Salt.

Road Piece, 1927.

Area of each plot $\frac{1}{4}$ acre. Basal dressing : 3 cwt. superphosphate, 2 cwt. Kainit and 1 cwt. Sulphate of Ammonia per acre.

Plot Number.	1	2	3	4	5	6
Manuring : per acre.	No Top Dressing.	1 cwt. Sulphate of Ammonia.	Nitrate of Soda equiv. to S/Am.	1 cwt. S/Amm. 3 cwt. Salt.	Nitrate of Soda equiv. to S/Am. 3 cwt. Salt.	3 cwt. Salt.
Produce of Roots in tons per acre	14.24	16.91	18.20	19.79	20.05	20.51

LUCERNE, INOCULATION OF.

Mill Dam Close, 1928.

Yield of Lucerne Hay per plot (.15 acre).
Inoculated.

Plot Number.	1	3	5	7	9	11	Total.	Average per acre, cwt.
Yield in lb.	714	658	602	553	644	602	3773	37.4

Not Inoculated.

Plot Number.	2	4	6	8	10	—	Total.	Average per acre, cwt.
Yield in lb.	532	658	504	420	476	—	2590	30.8

Difference in favour of the Inoculated Plots = 6.6 cwts. per acre.

Standard Error of this Difference = 2.6 cwts.

The yield of hay from the Inoculated Plots is significantly greater than that from the not-Inoculated Plots.