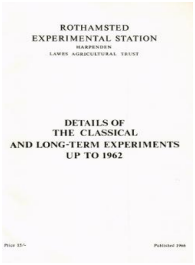
ROTHAMSTED RESEARCH

Details of the Classical and Long-term Experiments Up to 1962



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Broadbalk- Wheat

Rothamsted Research

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BROADBALK WHEAT, 1843 ONWARDS

The first experimental crop was harvested in 1844 after a rotation of turnips (dunged) 1839, barley 1840, peas 1841, wheat 1842, oats 1843, the last four crops being entirely unmanured. Wheat has been grown experimentally every year since. The manurial treatments varied somewhat in the first eight years, but the experiment attained its permanent form in 1852. Most of the treatments, with certain exceptions noted below, have been applied to their respective plots year after year since that year.

Table 1. Manures applied per acre since 1852 unless otherwise stated

Plot Number	Treatment D tons	P P_2O_5 lb (1)	K K_2O lb (2)	Na lb (2)	Mg lb (2)	N N lb (3)	N′ N lb	R N lb	Notes
2A	14	-	-	-	-	-	-	-	(4)
2B	14	-	-	-	-	-	-	-	
3	-	-	-	-	-	-	-	-	(5)
5	-	65	98	100	100	-	-	-	
6	-	65	98	100	100	43(N_1)	-	-	
7	-	65	98	100	100	86(N_2)	-	-	
8	-	65	98	100	100	129(N_3)	-	-	
9	-	65	98	100	100	-	43(N'_1)	-	(6)
10	-	-	-	-	-	86	-	-	
11	-	65	-	-	-	86	-	-	
12	-	65	-	366	-	86	-	-	
13	-	65	98	-	-	86	-	-	
14	-	65	-	-	280	86	-	-	
15	-	65	98	100	100	86(N_2^+)	-	-	(9)
16	-	65	98	100	100	-	86(N'_2)	-	(7)
17	as plot 5 in odd years, as plot 10 in even years								
18	as plot 10 in odd years, as plot 5 in even years								
19	-	-	-	-	-	-	-	86	(10)
20	-	-	98	100	100	86	-	-	(11)

Plot sizes vary (8) but are approximately as follows:-
Full sections in fallowing cycle 0.10 acres, half sections 0.05 (approximately). Continuous wheat 0.028 acres.

Treatments: D: farmyard manure. P: superphosphate. K: sulphate of potash. Na: sulphate of soda. Mg: sulphate of magnesia. N. sulphate of ammonia. N′: nitrate of soda. R: castor meal.

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BROADBALK

Notes:

(1) Until 1888 superphosphate was made from 200 lb. bone ash and 150 lb. sulphuric acid; from 1889-1897 it was made from mineral phosphate; from 1898-1902 basic slag was used in place of superphosphate.

(2) Until 1858 the dressing of sulphate of potash provided 147 lb. K_2O and the sulphate of soda was applied at 200 lb. per acre. On plot 12 the sulphate of soda was 550 lb. and on plot 14 the sulphate of magnesia was 420 lb.

(3) Until 1916 those plots which now receive sulphate of ammonia had a mixture of equal parts of ammonium sulphate and ammonium chloride (the "ammonium salts" of the early reports). The ammonium salts were all applied in autumn till 1877, they were all applied in spring till 1883. In 1884 the present method was adopted of giving 21 lb. N in the autumn and the remainder in spring. Except for the short period 1873-1877 plot 15 has always had the whole of its nitrogen in autumn.

(4) Since 1885.

(5) Since 1840.

(6) Plot 9 tested nitrate of soda at various rates (usually 550 lb.) with or without minerals since 1852-1893.

(7) Since 1884. Plot 16 received 800 lb. ammonium salts with "minerals" as on plot 5 from 1852-1864. It was then unmanured from 1865-1883.

(8) The original plots consisted of 2 "lands" each of $\frac{1}{4}$ acre side by side. In the early days these lands sometimes carried different, but related, treatments. In 1894 the pairs of lands were thrown together to give $\frac{1}{2}$ acre plots each carrying a single treatment. It was these plots that were divided transversely into 5 equal sections in 1926.

(9) All in autumn.

(10) Castor meal since 1941, previously rape cake. From 1852-1878 the quantity of rape cake was 500 lb. in addition to superphosphate and ammonium salts. In 1879 the minerals were stopped and the rape cake dressing was increased to provide about 86 lb. N.

(11) Since 1906.

For more detailed description of the materials used and minor changes in procedure see Imp. Bur. Soil Sci. Tech. Commun. No. 40, (1940) pp. 162-163. Also Memoranda of the Field Experiments 1901, pp. 30-31; and J. agric. Sci. (1921), 11, 107.

Weeds have always been a serious problem on Broadbalk and in spite of regular hand-weeding and inter-row cultivation occasional bare fallows had to be given. The following is a record of the bare fallows and other cleaning operations:-

1889	The wheat on one half of the field was drilled in wide rows (about 16") to allow thorough inter-row cultivation.
1890	Same operation on the other half.
1904	Each plot was divided into halves longitudinally one half being cropped and the other bare fallowed.
1905	Strips reversed.
1906-1925	Crop grown on 12" rows to enable inter-row cultivation to be carried out.
1914	All the Western half bare fallowed.
1915	All the Eastern half fallowed.

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1926 The field was divided transversely into five sections.
1926, 1927 Sections I, II, III bare fallowed.
1928, 1929 Sections III, IV, V bare fallowed.
The whole field was cropped in 1930 and in 1931 a regular system of fallowing was started: the five sections being fallowed in turn, each section carrying four wheat crops in succession and then having one year's rest with sufficient summer cultivation to keep down weeds.

In 1956 Section I was divided into two: Ia nearest the farm was assigned to continuous wheat with weedkillers as required but no fallows, while Ib continued in the 5-year cycle. The situation in the years 1951-1961 inclusive is given in tabular form below.

System of Cropping and Fallowing

	Ia	Ib	II	III	IV	V
1951	F	F	4	1	2	3
1952	1	1	F	2	3	4
1953	2	2	1	3	4	F
1954	3	3	2	4	F	1
1955	4	4	3	F	1	2
1956	5	F	4	1	2	3
1957	6	1	F	2	3	4
1958	7	2	1	3	4	F
1959	8	3	2	4	F	1
1960	9	4	3	F	1	2
1961	10	F	4	1	2	3

1, 2, 3, 4.. . . . first, second, third, fourth . . . . crop after fallow (F).

Section Ia in cycle till 1955, then continuous cropping. The crop in Ia in 1956 is actually the 5th continuous crop on this land.

Wild oats (Avena ludoviciana) have been hand-pulled on Broadbalk regularly since 1943. For a summary of the results of the first 4 fallowing cycles, 1935-1954, see Rep. Rothamst. Exp. Sta. for 1955, pp. 161-165.

In recent years it was known that parts of Broadbalk were becoming acid. The acidity was partly due to position in the field but it mainly arose out of the continued use of ammonium salts and rape cake (now castor meal). In autumn 1954 a liming scheme was begun as follows:-

Yearly dressings:

(a) On plots receiving sulphate of ammonia, 100 lb. calcium carbonate per 14 lb. N as sulphate of ammonia.
(b) On plot receiving castor meal, 50 lb. calcium carbonate per 14 lb. N as castor meal.

In the first year the dressings of chalk on the ammonium sulphate and castor meal plots were applied at double the prescribed rates. Section V was divided transversely into two equal parts a and b which are harvested separately. Section Vb, nearest the drain, received a single corrective dressing of 5 tons of calcium carbonate per acre.

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BROADBALK

For details of the liming on Broadbalk see Rep. Rothamst. exp. Sta. for 1954, pp. 146-148.

Harvesting: Until 1900 by hand; 1901-1956 by binder; commencing in 1957 the plots were harvested by combine harvester, one combine cut per plot being weighed. Straw weights are taken after baling but some of the chaff, small cavings and dust is left on the plots.

Weedkillers: On Section Ia only, 1957 MCPA, 1958 mecoprop, 1959 2,3,6 - TBA/MCPA mixture, 1960 mecoprop, 1961 and 1962 2,3,6 - TBA/MCPA. Also, to stubble in autumn 1959, 2, 4-D.

Variety: Squarehead's Master since 1900. Previously Old Red Lammas 1844-1848, Old Red Cluster 1849-1852, Red Rostock 1853-1881, Red Club 1882-1899.

Results: Russell, E.J. & Watson, D.J. (1940). The Rothamsted experiments on the growth of wheat. Imp. Bur. Soil Sci. Tech. Comm. No. 40.

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Table 2

WHEAT - BROADBALK
Grain: cwt per acre
5 year means

Plot	Treatment Symbols	1935 - 39				1940 - 44				1945 - 49				1950 - 54				1955 - 59				Mean 1935 - 59				IA 1955-59
years after fallow		1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	
2A	D	20.6	14.6	15.4	13.7	25.8	22.4	19.8	15.0	27.3	21.7	20.1	17.5	26.9	21.4	21.8	21.3	27.2	23.4	21.1	20.0	25.5	20.7	19.6	17.5	19.8
2B	D	21.2	18.5	16.3	14.9	26.9	24.1	24.5	19.4	28.3	25.1	21.6	18.9	26.4	22.8	22.4	23.2	27.8	24.8	22.7	22.8	26.2	23.1	21.5	19.9	20.2
3	O	12.5	6.4	7.1	7.1	19.0	10.0	10.6	10.6	16.5	10.2	8.0	7.9	16.4	9.4	9.1	9.0	17.3	10.4	11.0	11.0	16.3	9.3	9.2	9.1	12.0
5	PKNaMg	16.3	9.5	7.9	7.5	21.4	10.1	11.7	11.6	20.3	10.5	9.5	10.1	17.8	11.0	9.0	11.9	18.4	10.5	11.2	13.6	18.8	10.3	9.8	10.9	15.4
6	N_1PKNaMg	19.4	11.9	10.0	10.9	24.3	14.3	15.2	15.3	23.1	14.1	11.4	11.4	21.3	15.1	12.7	14.2	22.0	15.3	14.7	16.8	22.0	14.2	12.8	13.7	16.6
7	N_2PKNaMg	19.9	15.8	14.2	14.0	27.7	20.7	21.7	21.3	26.1	19.0	14.7	16.1	22.8	19.5	17.6	17.7	23.0	22.0	19.1	19.9	23.9	19.4	17.5	17.8	20.3
8	N_3PKNaMg	20.7	18.5	15.8	14.9	27.2	22.9	22.9	23.4	27.0	24.1	20.4	19.3	24.2	23.0	20.8	22.6	26.1	25.0	21.1	21.0	25.1	22.7	20.2	20.2	21.8
9	N_1'PKNaMg	19.2	13.6	11.5	12.3	25.4	17.3	16.5	18.4	21.7	15.8	12.6	12.7	20.5	16.1	15.9	16.1	22.9	18.4	17.5	15.5	21.9	16.2	14.8	15.0	15.8
10	N_2	14.5	16.2	12.6	12.4	18.4	19.9	17.3	17.2	17.3	18.8	13.1	11.8	18.4	19.6	16.9	16.1	17.1	17.5	14.8	15.7	17.1	18.4	14.9	14.6	16.5
11	N_2P	14.5	13.6	11.9	10.9	20.5	19.0	16.5	16.3	16.1	16.9	14.3	13.1	17.5	17.5	16.9	16.1	16.9	19.9	15.6	15.1	17.1	17.4	15.0	14.3	18.6
12	N_2PNa	16.1	15.1	12.9	13.3	24.8	20.1	20.3	20.0	19.7	18.6	15.0	14.9	20.4	20.1	18.1	17.6	17.9	20.1	17.3	17.3	19.8	18.8	16.7	16.6	21.1
13	N_2PK	19.4	14.8	13.3	14.4	28.3	19.3	19.1	19.4	26.0	18.3	14.6	14.3	23.6	19.5	17.0	17.5	23.3	20.4	18.6	18.5	24.1	18.4	16.5	16.8	19.3
14	N_2PMg	16.3	15.5	13.0	13.9	26.5	19.8	19.4	19.2	20.7	21.2	16.1	15.1	22.3	18.5	19.0	17.1	18.8	20.0	16.8	17.0	20.9	19.0	16.8	16.5	20.7
15	N_2^+PKNaMg	18.8	14.4	12.9	14.0	26.4	17.9	18.3	19.3	23.3	16.6	14.5	14.4	24.6	15.6	14.9	15.0	22.6	16.2	15.3	16.4	23.1	16.1	15.2	15.8	17.8
16	N_2' PKNaMg	20.0	17.3	15.5	15.5	29.6	23.5	24.2	23.4	26.2	21.5	18.3	18.3	24.4	22.8	20.5	20.9	24.7	23.7	22.6	22.1	25.0	21.7	20.2	20.0	21.2
17 & 18C*	PKNaMg	15.2	8.1	6.4	7.5	22.4	9.5	8.6	9.2	17.8	9.1	7.2	6.8	19.8	10.6	8.2	6.6	17.3	10.0	9.0	8.9	18.5	9.4	7.9	7.8	8.7
17 & 18N_2*	N_2	18.0	14.9	14.7	14.8	27.2	20.1	21.2	21.0	22.4	16.8	16.7	17.5	23.7	19.0	17.3	19.0	24.6	16.9	19.2	20.6	23.2	17.5	17.8	18.6	19.1
19	R	19.1	15.2	12.5	13.3	28.3	19.3	17.7	18.0	22.5	18.1	15.2	15.3	20.5	16.8	14.2	15.5	21.9	16.4	13.9	16.3	22.5	17.2	14.7	15.7	16.8
20§	N_2KNaMg	20.4	20.3	9.7	7.0	23.6	20.3	17.2	17.3	11.8	20.4	14.9	13.2	19.0	21.1	14.1	16.4	23.6	15.6	17.2	13.4	19.7	19.6	14.6	13.4	16.4

* treatments in alternate years

§ Means of 2 years only per cycle

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