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Results of the
Classical and other
Long-term Experiments
2007

R/BK/1 Broadbalk

Rothamsted Research

Rothamsted Research (2007) *R/BK/1 Broadbalk* ; Yields Of The Field Experiments 2007, pp 5 - 13 -
DOI: <https://doi.org/10.23637/ERADOC-1-217>

07/R/BK/1

BROADBALK

Object: To study the effects of organic manures and inorganic fertilisers on continuous w. wheat and wheat in rotation. From 1968 two three-year rotations were included: potatoes, beans, w. wheat and fallow, w. wheat, w. wheat. In 1979 the first rotation was changed to fallow, potatoes, w. wheat. In 1980 the second rotation reverted to continuous w. wheat. Since 1985 part of the second rotation was added to the first to extend the rotation to fallow, potatoes, w. wheat, w. wheat, w. wheat. In 1996 the fallow was replaced by w. oats and potatoes replaced by maize in 1997.

The 164th year, w. wheat, w. oats and forage maize.

For previous years see 'Details' 1967 and 1973, Station Report for 1966, pp. 229-234; Station Report for 1968, Part 2; Station Report for 1982, Part 2, pp 5-44 and Yield Books for 74-06R//BK/1.

Areas harvested:

	Section	
Wheat:	0	0.00320
	1	0.00589
	2,4,6 and 7	0.00487 (*see note 4, below)
	8,9	0.00512
Oats:	3	0.00487
Maize:	5	0.00162

Treatments:

In 2001 a number of the treatments were changed. The treatments are now:-

Whole plots

PLOT	Fertilizers and organic manures	
	Plot	Treatments
01 (FYM)N4	01	From 2001 N4
21FYMN3	2.1	FYM N2 ⁽¹⁾
22FYM	2.2	FYM
03Nil	03	None
05(P)KMg	05	(P) K Mg
06N1 (P) KMg	06	N1 (P) K Mg
07N2(P)KMg	07	N2 (P) K Mg
08N3(P)KMg	08	N3 (P) K Mg
09N4(P)KMg	09	N4 (P) K Mg
10N4	10	N4
11N4PMg	11	N4 P Mg
12N1+3+1(P)K2Mg2	12	N1+3+1 (P) K2 Mg2 ⁽²⁾
13N4PK	13	N4 P K
14N4PK*(Mg*)	14	N4 P K* (Mg*)
15N5(P)KMg	15	N5 (P) K Mg
16N6(P)KMg	16	N6 (P) K Mg
17N1+4+1PKMg	17	N1+4+1 P K Mg
18N1+2+1PKMg	18	N1+2+1 P K Mg
19N1+1+1KMg	19	N1+1+1 K Mg
20N4KMg	20	N4 K Mg

(1) FYM N3 since 2005

(2) N1+3+1 (P) KMg since 2006

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W. oats; Nitrogen and farmyard manure were not applied.

N1, N2, N3, N4, N5, N6: 48, 96, 144, 192, 240, 288 kg N as 33.5% N; to be applied at the same time as the second dressings in the split nitrogen plots for wheat and to the seedbed for forage maize.

Split N to wheat

N1+1+1, 1+2+1 etc: Rates as above. Timings: first two weeks of March, GS31 or mid-April (whichever comes first) and GS37/mid-May.

Split N to forage maize

N2+1, 2+2, 2+3,2+4: Rates as above. Timings: to the seedbed and post-emergence.

P: 35 kg P as triple superphosphate

(P): (none), to be reviewed in 2010/11.

K: 90 kg K as potassium sulphate.

K2: 180 kg K as potassium sulphate (plus 450 kg K autumn 2000 only)

K*: 90 kg K as potassium chloride

Mg: 12 kg Mg as kieserite.

Mg2: 24 kg Mg as kieserite.

(Mg*): (none), to be reviewed in 2010/11

FYM: Farmyard manure at 35 t

Previous treatment:-

Whole plots

PLOT	Plot	Fertilizers and organic manures:-		
		Treatments until 1967	Treatments from 1968	Treatments from 1985 – 2000
01DN4PK	01	-	D N2 P K	D N4 P K
21DN2	21	D	D N2	D N2
22D	22	D	D	D
030	03	None	None	None
05F	05	P K Na Mg	P K (Na) Mg	PK Mg
06N1F	06	N1 P K Na Mg	N1 P K (Na) Mg	N1 P K Mg
07N2F	07	N2 P K Na Mg	N2 P K (Na) Mg	N2 P K Mg
08N3F	08	N3 P K Na Mg	N3 P K (Na) Mg	N3 P K Mg
09N4F	09	N*1 P K Na Mg	N4 P K (Na) Mg	N4 P K Mg
10N2	10	N2	N2	N2
11N2P	11	N2 P	N2 P	N2 P
12N2PNA	12	N2 P Na	N2 P Na	N2 P Na
13N2PK	13	N2 P K	N2 P K	N2 P K
14N2PKMG	14	N2 P Mg	N2 P K Mg	N2 P K Mg
15N5F	15	N2 P K Na Mg	N3 P K (Na) Mg	N5 P K Mg
16N6F	16	N*2 P K Na Mg	N2 P K (Na) Mg	N6 P K Mg
17N1+3FH	17	N2 (A)	N2 ½[P K (Na) Mg]	N1+3 ½[P K Mg] (A)+
18N0+3FH	18	P K Na Mg (A)	N2 ½[P K (Na) Mg]	N0+3 ½[P K Mg] (A)+
19(C)	19	C	C	(C) (since 1989)
20N2KMG	20	N2 K Na Mg	N2 K (Na) Mg	N2 K Mg

(A) Alternating each year

+ This change since 1980. Treatments shown are those to w. wheat; autumn N alternates. Maize received N3 ½[PK Mg] on both plots 17 and 18. These treatments shown incorrectly in 1999-2002 Yield books.

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W. oats; Nitrogen and dung were not applied.

- N1, N2, N3, N4, N5, N6: 48, 96, 144, 192, 240, 288 kg N as sulphate of ammonia until 1967, except N* which was nitrate of soda. All as 'Nitro-Chalk' in spring from 1968 to 1985, as 34.5% N since 1986.
- N0+3; N1+3: None in autumn + 144 kg N in spring; 48 kg N in autumn + 144 kg N in spring.
- P: 35 kg P as triple superphosphate in 1974 and since 1988, single superphosphate in other years
- K: 90 kg K as sulphate of potash
- Na: 55 kg Na as sulphate of soda
- (Na): 16 kg Na as sulphate of soda until 1973
- Mg: 30kg Mg annually to Plot 14 (applied at 26 kg 1990 to 2000), 35 kg Mg every third year to other plots since 1974 (applied at 30 kg in 1991, 1994, 1997 and 2000 and at 15 kg on half rate treatments). All as kieserite since 1974, previously as sulphate of magnesia annually.
- D: Farmyard manure at 35 t
- (C): Castor meal to supply 96 kg N until 1988, none since
- F: Full rate P K (Na) Mg as above
- H: Half rate of above.

Strips of sub-plots: Until 1967 wheat alone was grown on the experiment, with some bare fallowing. From 1968, the experiment was divided into 10 sections with the following cropping:-

SECTION

Section	1	9	0*	8+	6**	5	3	7	4	2
Year										
1968	W	W	W	W	F	W	W	P	W	BE
1969	W	W	W	W	W	F	W	BE	P	W
1970	W	W	W	W	W	W	F	W	BE	P
1971	W	W	W	W	F	W	W	P	W	BE
1972	W	W	W	F	W	F	W	BE	P	W
1973	W	W	W	W	W	W	F	W	BE	P
1974	W	W	W	W	F	W	W	P	W	BE
1975	W	W	W	W	W	F	W	BE	P	W
1976	W	W	W	W	W	W	F	W	BE	P
1977	W	W	W	W	F	W	W	P	W	BE
1978	W	W	W	W	W	F	W	BE	P	W
1979	W	W	W	W	W	W	F	W	P	F
1980	W	W	W	W	W	W	W	F	W	P
1981	W	W	W	F	W	W	W	P	F	W
1982	W	W	W	W	W	W	W	W	P	F
1983	W	W	W	W	W	W	W	F	W	P

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Section	1	9	0*	8+	6**	5	3	7	4	2
Year										
1984	W	W	W	W	W	W	W	P	F	W
1985	W	W	W	W	W	F	W	W	P	W
1986	W	W	W	W	W	P	F	W	W	W
1987	W	W	W	W	W	W	P	W	W	F
1988	W	W	W	F	W	W	W	F	W	P
1989	W	W	W	W	W	W	W	P	F	W
1990	W	W	W	W	W	F	W	W	P	W
1991	W	W	W	W	W	P	F	W	W	W
1992	W	W	W	W	W	W	P	W	W	F
1993	W	W	W	W	W	W	W	F	W	P
1994	W	W	W	F	W	W	W	P	F	W
1995	W	W	W	W	W	F	W	W	P	W
1996	W	W	W	W	W	P	O	W	W	W
1997	W	W	W	W	W	W	M	W	W	O
1998	W	W	W	W	W	W	W	O	W	M
1999	W	W	W	W	W	W	W	M	O	W
2000	W	W	W	W	W	O	W	W	M	W
2001	W	W	W	F	W	M	O	W	W	W
2002	W	W	W	W	W	W	M	W	W	O
2003	W	W	F	W	W	W	W	O	W	M
2004	W	W	F	W	W	W	W	M	O	W
2005	W	W	W	W	W	O	W	W	M	W
2006	W	W	W	W	W	M	O	W	W	W
2007	W	W	W	W	W	W	M	W	W	O

W = w. wheat, O = w. oats (spring oats 2001), P = potatoes, BE = s. beans, F = fallow, M = forage maize

* Straw incorporated since autumn 1986. ** No sprays except weedkillers since 1985.

+ No weedkillers.

NOTES:

- (1) For a fuller record of treatments see 'Details' etc.
- (2) From autumn 1975 to autumn 1986, chalk was applied at 2.9t each autumn to all plots in sets of Sections on a three-year cycle. Year 1: Sections 1, 2, 3. Year 2: Sections 6, 7, 8, 9. Year 3: Sections 0, 4, 5. From autumn 1988 until autumn 1992 a five-year cycle was used. Year 1: Sections 1, 3. Year 2: Sections 2, 8. Year 3: Sections 7, 9. Year 4: Sections 4, 6. Year 5: Sections 0, 5. None applied since autumn 1991.
- (3) In 2003 and 2004 section 0 was used for an experiment (CS/595) investigating different herbicides to control *Equisetum arvense*.
- (4) In 2006 parts of plots 2.2, 06, 09 and 14 on Section 4 used for a nutrition trial with the application of urea. 5m was cut off the end of these plots before the yield measurement was taken.

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Experimental Diary:

All Sections:		Rate	Unit
05-Sep-06	p Weedazol-TL Sections 0-4, 6, 7, 9	20.00	l/200 l/ha
28-Sep-06	a Topped Section 8	1.00	
04-Oct-06	f Farm Yard Manure Strips 21, 22, excluding section 2	35.00	t/ha
09-Oct-06	f Triple superphosphate strips 11, 13, 14, 17, 18	171.00	kg/ha
	f Muriate of Potash Strip 14	181.00	kg/ha
14-Oct-06	a Plough/S		
16-Oct-06	a Cultipressed		
09-Jan-07	a Erect rabbit fence		
12-Mar-07	f Sulphate of Potash Strips 5-9, 12, 13, 15-20	217.00	kg/ha
14-Mar-07	f Kieserite Strips 5-9, 11, 12, 15-20, strip 10 section 9 in error	80.00	kg/ha
01-May-07	a Flexitined E and W headlands		
08-May-07	a Mow / Rotavate paths		
09-May-07	a Mow / Rotavate paths		
10-May-07	a Remove rabbit fence S O&E's		
	a Flexitined O&E's		
11-May-07	a Power Harrowed O&E's		
25-May-07	a Mow / Rotavate paths		
14-Jun-07	a Mow / Rotavate paths		
19-Jun-07	a Mow / Rotavate paths		
25-Jun-07	a Mow/Rotavate paths - down paths		
26-Jul-07	a Mow / Rotavate paths		
10-Aug-07	a Rogue wild oats/thistles/weeds		
10-Sep-07	a Remove rabbit fence		

Cropped sections:

W. Wheat		Rate	unit
01-Nov-06	a Combination drilled wheat plots		
	s Hereward tr Redigo Twin + Deter	350.00	seeds/m ²
03-Nov-06	p Ice Sections 0, 1, 4-7, 9	4.00	l/200 l/ha
04-Dec-06	p Decoy Wetex excluding section 3	7.00	kg/ha
14-Mar-07	f Nitraprill strips 12, 17, 18, 19, wheat	139.00	kg/ha
23-Apr-07	p Clean Crop Wanderer all wheat except section 6	1.00	l/200 l/ha
	p Deuce all wheat except section 6	1.00	l/200 l/ha
24-Apr-07	f Nitraprill strips 6, 19, wheat	139.00	kg/ha
	f Nitraprill strips 7, 18, wheat	278.00	kg/ha
	f Nitraprill strips 21, 8, 12, wheat	417.00	kg/ha
	f Nitraprill strips 1, 9, 10, 11, 13, 14, 17, 20, wheat	556.00	kg/ha
	f Nitraprill strip 15, wheat	696.00	kg/ha
	f Nitraprill strip 16, wheat	835.00	kg/ha

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		Rate	Unit
09-May-07	p Ally Max SX wheat and oats excluding section 8	42.00	g/200 l/ha
	p Starane 2 wheat and oats excluding section 8	0.75	l/200 l/ha
22-May-07	p Amistar Opti wheat excluding Sec 6	1.25	l/200 l/ha
	p Opus wheat excluding Sec 6	0.60	l/200 l/ha
11-Jun-07	f Nitraprill Strips 12, 17, 18, 19, wheat Double Top 2 m on W end of plots 225 and 095	139.00	kg/ha
12-Jun-07	f Double Top 2 m on W end of plots 225 and 095	40.00	Kg N/ha
14-Jun-07	p Amistar Opti wheat, excluding section 6	1.00	l/200 l/ha
	p Landgold Epoxiconazole wheat, excluding section 6	0.40	l/200 l/ha
26-Aug-07	a Combine harvest, plots for yield, and swath straw - sections 0 and 1		
27-Aug-07	a Combine harvest, plots for yield and swath straw - sections 4-9		
	a Sample, bale and weigh straw section 1		
28-Aug-07	a Combine harvest plot edges to allow straw weight to be taken		
	a Sample, bale and weigh straw sections 5 & 8		
29-Aug-07	a Combine harvest discards and swath straw		
	a Chop straw section 0		
02-Sep-07	a Baled remaining wheat straw		

W. Oats

		Rate`	Unit
02-Nov-06	a Combination drilled oat plots		
	s Gerald r Baytan Secure	350.00	seeds/m ²
04-Dec-06	s Decoy Wetex excluding section 3	7.00	kg/ha
19-Dec-06	p Lexus Class - oats	60.00	g/200 l/ha
	p Hallmark with Zeon Technology - oats	50.00	ml/200 l/ha
09-May-07	p Ally Max SX wheat and oats excluding section 8	42.00	g/200 l/ha
	p Starane 2 wheat and oats excluding section 8	0.75	l/200 l/ha
24-May-07	p Amistar - oats	0.60	l/200 l/ha
	p Flexity - oats	0.20	l/200 l/ha
06-Aug-07	a Combine harvest plots for yield and swath straw - oats		
08-Aug-07	a Sample, bale and weigh straw - oats		
11-Aug-07	a Baled discard oat straw		

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Forage Maize			Rate	Unit
21-Apr-07	p	Clinic Ace - section 3, pre Maize	4.00	l/200 l/ha
01-May-07	a	Flexitined maize plots		
02-May-07	f	Maize N and 1 st N Nitraprill plot 063, maize	139.00	kg/ha
	f	Maize N and 1 st N Nitraprill Plots 073, 123, 173, 183, 193, maize	278.00	kg/ha
	f	Maize N and 1 st N Nitraprill Plots 213, 083, maize	417.00	kg/ha
	f	Maize N and 1 st N Nitraprill Plots 013, 093, 103, 113, 133, 143, maize	556.00	kg/ha
	f	Maize N and 1 st N Nitraprill Plot 153, maize	696.00	kg/ha
	f	Maize N and 1 st N Nitraprill Plot 163, maize	835.00	kg/ha
	a	Power Harrowed Maize plots		
	a	Nodet drilled maize plots		
	s	Hudson Tr Mesurol maize plots	10.20	seeds/m ²
	a	Rolled maize plots		
06-Jun-07	f	2 nd split N Nitraprill Plot 193, maize	139.00	kg/ha
	f	2 nd split N Nitraprill Plot 183, maize	278.00	kg/ha
	f	2 nd split N Nitraprill Plot 123, maize	417.00	kg/ha
	f	2 nd split N Nitraprill Plot 173, maize	556.00	kg/ha
14-Jun-07	p	Samson maize plots	1.50	l/200 l/ha
19-Jun-07	p	Callisto maize plots	0.75	l/200 l/ha
18-Sep-07	a	Cut harvest strips, weighed and sampled - maize		
25-Sep-07	a	Cut maize discards		
Wilderness			Rate	Unit
30-Apr-07	a	Topped Wilderness, middle section		
01-Jun-07	a	Topped grazed section		
18-Jun-07	a	Topped Wilderness, middle section		
25-Sep-07	a	Topped Wilderness, middle section		
21-Dec-07	a	Topped Wilderness, middle section		

Note: Samples of wheat and oat grain and straw, and maize were taken for chemical analysis. Unground wheat grain and straw from section 1 and maize from section 3 were archived.

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WHEAT

GRAIN TONNES/HECTARES

*****Tables of means *****

SECTION PLOT	5/W1	4/W2	7/W3	8/W6	6/W30	0/W3	1/W41	9/W49	Mean
01 (FYM)N4	8.60	6.68	6.23	*	3.96	*	*	*	6.37
21FYMN3	9.90	9.00	8.48	2.48	5.01	5.24	6.21	7.96	6.78
22FYM	5.31	3.86	3.66	2.18	3.91	2.55	3.94	4.96	3.80
03N11	1.07	1.07	1.17	1.33	0.97	0.50	0.85	0.17	0.99
05 (P) KMg	1.33	1.20	1.03	2.24	0.92	0.41	1.05	0.71	1.11
06N1 (P) KMg	3.29	3.14	1.52	1.70	1.56	1.14	2.02	2.19	2.07
07N2 (P) KMg	4.96	4.30	2.46	1.35	1.59	2.16	3.22	2.24	2.78
08N3 (P) KMg	5.67	5.14	3.34	1.92	1.89	1.97	3.12	2.89	3.24
09N4 (P) KMg	7.31	6.04	5.22	2.27	2.90	4.28	4.93	4.89	4.73
10N4	6.04	3.79	0.66	0.79	1.73	0.76	1.11	0.35	1.90
11N4PMg	4.64	2.96	3.31	1.80	1.87	2.56	2.54	3.19	2.86
12N1+3+1 (P) K2Mg2	8.29	6.39	5.19	2.59	2.68	4.62	4.82	5.19	4.97
13N4PK	7.15	5.40	4.45	1.54	2.54	3.52	4.29	4.20	4.14
14N4PK* (Mg*)	6.91	5.05	3.68	1.46	2.48	3.46	4.31	4.52	3.98
15N5 (P) KMg	7.89	6.11	4.12	1.30	2.13	3.39	3.90	4.30	4.14
16N6 (P) KMg	9.00	7.50	5.91	1.77	4.10	5.67	5.29	4.97	5.53
17N1+4+1PKMg	8.76	7.71	6.05	2.01	4.29	5.41	5.16	4.80	5.52
18N1+2+1PKMg	7.98	6.79	5.48	2.19	2.84	3.76	3.77	2.61	4.43
19N1+1+1KMg	6.02	5.11	4.02	1.81	2.42	2.73	3.91	1.30	3.42
20N4KMg	*	*	*	*	*	0.99	0.41	*	0.70

GRAIN MEAN DM% 82.2

STRAW TONNES/HECTARES

***** Tables of means *****

SECTION PLOT	5/W1	4/W2	7/W3	8/W6	6/W30	0/W3	1/W41	9/W49	Mean
01 (FYM)N4	3.51	*	*	*	*	*	*	*	3.51
21FYMN3	4.58	*	*	5.51	*	*	2.21	*	4.10
22FYM	2.49	*	*	4.80	*	*	1.93	*	3.08
03N11	0.13	*	*	2.31	*	*	0.16	*	0.87
05 (P) KMg	0.26	*	*	4.83	*	*	0.23	*	1.77
06N1 (P) KMg	0.86	*	*	2.86	*	*	0.33	*	1.35
07N2 (P) KMg	1.73	*	*	3.23	*	*	0.84	*	1.93
08N3 (P) KMg	1.26	*	*	3.17	*	*	0.81	*	1.74
09N4 (P) KMg	2.35	*	*	4.69	*	*	1.62	*	2.89
10N4	1.38	*	*	3.48	*	*	0.30	*	1.72
11N4PMg	0.90	*	*	4.41	*	*	0.56	*	1.96
12N1+3+1 (P) K2Mg2	2.27	*	*	5.24	*	*	1.38	*	2.96
13N4PK	1.90	*	*	4.51	*	*	1.23	*	2.55
14N4PK* (Mg*)	1.78	*	*	5.89	*	*	0.92	*	2.86
15N5 (P) KMg	2.24	*	*	6.56	*	*	1.19	*	3.33
16N6 (P) KMg	3.03	*	*	5.89	*	*	1.60	*	3.51
17N1+4+1PKMg	2.81	*	*	4.26	*	*	1.39	*	2.82
18N1+2+1PKMg	2.79	*	*	5.39	*	*	1.04	*	3.07
19N1+1+1KMg	1.85	*	*	5.01	*	*	1.15	*	2.67
20N4KMg	*	*	*	*	*	*	0.02	*	0.02

STRAW MEAN DM% 86.2

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W.OATS

TONNES/HECTARE

***** Tables of means *****

PLOT	GRAIN	STRAW
01 (FYM) [N4]	5.10	2.57
21 [FYMN2]	6.87	4.13
22 [FYM]	7.21	4.18
03Nil	1.93	0.65
05 (P) KMg	2.52	0.85
06 [N1] (P) KMg	2.96	1.14
07 [N2] (P) KMg	3.29	1.24
08 [N3] (P) KMg	3.74	1.77
09 [N4] (P) KMg	3.65	1.77
10 [N4]	5.11	2.37
11 [N4] PMg	5.31	2.40
12 [N1+3+1] (P) K2Mg2	3.97	1.61
13 [N4] PK	3.39	1.41
14 [N4] PK* (Mg*)	3.32	1.57
15 [N5] (P) KMg	3.85	1.67
16 [N6] (P) KMg	5.87	2.93
17 [N1+4+1] PKMg	5.37	2.63
18 [N1+2+1] PKMg	3.45	1.62
19 [N1+1+1] KMg	2.60	1.25
MEAN DM%	87.3	84.8

PLOT AREA HARVESTED 0.00487

FORAGE MAIZE

WHOLE CROP (100% DM) TONNES/HECTARES

***** Tables of means *****

PLOT	Whole Crop
01 (FYM) N4	14.74
21 FYMN3	14.58
22 FYM	13.99
03Nil	2.15
05 (P) KMg	3.57
06N1 (P) KMg	6.67
07N2 (P) KMg	9.20
08N3 (P) KMg	11.35
09N4 (P) KMg	12.82
10N4	0.93
11N4 PMg	3.66
12N2+3 (P) K2Mg2	10.90
13N4 PK	11.19
14N4 PK* (Mg*)	11.06
15N5 (P) KMg	11.43
16N6 (P) KMg	11.10
17N2+4 PKMg	9.25
18N2+2 PKMg	8.79
19N2+1 KMg	7.37
MEAN%DM	24.40

PLOT AREA HARVESTED 0.00162