ROTHAMSTED RESEARCH

Yields of the Field Experiments 2001

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01/R/BK/1 - Broadbalk

Rothamsted Research

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01/R/BK/1

BROADBALK

Object: To study the effects of organic manures and inorganic fertilisers on continuous w. wheat. 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 158th year, w. wheat, w. oats and forage maize.

For previous years see 'Details' 1967 and 1973, Station Report for 1966, pp. 229-231, Station Report for 1978, Part 2, Station Report for 1982, Part 2, pp. 5-44 and 74-00/BK/1.

Areas harvested:

	Section	
Wheat:	0	0.00366
	1	0.00673
	2,4,6 and 7	0.00556
	9	0.00585
Oats:	3	0.00556
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 Treatments Plot	from 2001
01(FYM)N4	01	N4
21FYMN2	21	FYM N2
22FYM	22	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 Kg
10N4	10	N4
11N4PMg	11	N4 P Mg
12N1+3+1(P)K2Mg2	12	N1+3+1 (P) K2 Mg2
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

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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 2004/5.

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 (plus 60 kg Mg, autumn 2000 only).

(Mg*): (none), to be reviewed in 2004/5.

FYM: Farmyard manure at 35 t

Previous treatment: -

Whole plots

PLOT		Fertilizers and organic manures:-		
	Plot	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 2(P K (Na) Mg)	N1+3 2(PK Mg) (A)+
18N0+3FH	18	P K Na Mg(A)	N2 2(P K (Na) Mg)	N0+3 2(PK 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 2(PK Mg) on both plots 17 and 18.

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: 30 kg 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, ten strips of sub-plots (sections) were started with the following cropping:-

SECTION	1/W34	9/W42	0/W49	8/W6	6/W23	5/O	3/W3	7/W1	4/M	2/W2
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
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

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SECTION

Section	1	9	0*	8+	6**	5	3	7	4	2
Year										
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

W = w. wheat, O = w. oats, 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 2.9 t 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.

Experimental diary:

All sections:

02-Oct-00	T	P	TSP at 171 kg, strips 11, 13, 14, 17, & 18.
04-Oct-00	T	FYM	FYM at 35.0 tonnes, strips 2.1 & 2.2, not oat section.
	T	K*	Muriate of potash at 181 kg, strip 14.
	T	K2	Sulphate of potash at 1518 kg, strip 12.
	T	K	Sulphate of potash at 217 kg, strips 5, 6, 7, 8, 9, 13, 15, 16, 17, 18, 19 & 20.
	T	MG2	Kieserite at 560 kg, strip 12.
	T	MG	Kieserite at 80 kg, strips 5, 6, 7, 8, 9, 11, 15, 16, 17, 18, 19 & 20.
	B		Ploughing started.
05-Oct-00	B		Ploughing completed.
12-Sep-01	B		Sting ECO at 4.0 l in 100 l, excluding section 8.

Cropped sections:

W. wheat

13-Aug-00	T		straw baled (sections 1, 2, 3, 5, 6, 7, 8 & 9)
17-Aug-00	T		chopped straw, section 0.
16-Jan-01	T	WW	Combination drilled, Hereward, tr. Sibutol, at 550 seeds/m^2 with Accord drill. Completed 17-Jan-2001 (no o&e's drilled).
26-Mar-01	T		1st split N applied.
04-May-01	T		Main N and 2nd split N applied
	T		Topik at 250 ml in 100 l.

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Experimental diary:

W. wheat

15-May-01	T		tm) Ally at 20 g in 100 l.
	T		tm) Starane 2 at 0.5 l in 100 l.
31-May-01	T		3rd split N applied
06-Jun-01	B		Opus at 0.7 l in 100 l, excluding section 6.
02-Jul-01	T		Folicur at 0.5 l in 200 l, excluding section 6.
07-Aug-01	T		Take pre-harvest samples from sections 9 and 4.
10-Aug-01	T		Azural at 4.0 l in 200 l, wheat and oats only, started.
11-Aug-01	T		Azural at 4.0 l in 200 l, wheat and oats only, completed.
21-Aug-01			Combined headlands, swathed straw.
22-Aug-01	T		Baled and removed straw from headlands.
23-Aug-01	T		Combine harvested plots for yield, swathed straw.
24-Aug-01	P		Combine harvested all remaining wheat, swathed straw.
	T		Sampled, baled and weighed straw.
25-Aug-01	T		Baled and carted straw, except section 0.

S. oats

02-Apr-01	T		Spring-tine cultivated.
03-Apr-01	T	SO	Combination drilled, Revisor, tr. Aagrano, at 350 seeds/m2.
15-May-01	T		tm) Ally at 20 g in 100 l.
	T		tm) Starane 2 at 0.5 l in 100 l.
10-Aug-01	T		Azural at 4.0 l in 200 l, wheat and oats only, started.
11-Aug-01	T		Azural at 4.0 l in 200 l, wheat and oats only, completed.
23-Aug-01	T		Combine harvested plots for yield, and discards, swathed straw.
24-Aug-01	T		Sampled, baled and weighed straw.
25-Aug-01	T		Baled and carted straw.

Forage maize

21-May-01	T		Rotary harrowed.
	T	FM	Drilled, Hudson, tr. Mesurol, at 102,000 seeds/ha, with Nodet Gougis drill.
	T		Sting ECO at 4.0 l in 200 l.
31-May-01	T		Main N and 1st split N applied
25-Jun-01	T		Post-emergence N applied.
03-Jul-01	T		Mutiny at 2.4 l in 200 l.
10-Sep-01	T		Cut, sampled and weighed sample areas.
11-Sep-01	T		Harvested discard maize.

Fallow section 8

11-May-01	T	Rotavated, section 8.
24-May-01	T	Rotary harrowed, section 8, and all discard areas.
04-Jul-01	T	Rotary harrowed, section 8.
26-Jul-01	T	Rotary harrowed.
12-Sep-01	T	Topped thistle patches on section 8.

Note: Poor weather in autumn delayed drilling of w. wheat.
Winter oats were replaced by spring oats.
Poor weather prevented timely application of some N.
Samples of wheat and oat grain and straw, and forage maize were taken for chemical analysis. Unground wheat grain and straw and maize samples from selected treatments were archived.

01/R/BK/1 W. WHEAT

GRAIN TONNES/HECTARE

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

SECTION / PLOT	4/W1	7/W2	2/W3	6/W24	1/W35	9/W43	0/W50
01(FYM)N4	5.25	5.29	5.04	5.42	*	*	*
21FYMN2	4.27	5.10	4.68	4.84	4.58	4.75	3.23
22FYM	1.70	1.96	1.95	1.83	2.17	2.24	1.34
03Nil	0.51	0.60	0.63	0.76	0.39	0.35	0.85
05(P)KMg	0.65	0.71	0.49	0.56	0.43	0.43	0.49
06N1(P)KMg	2.69	1.99	1.59	2.32	2.32	2.15	2.33
07N2(P)KMg	4.42	3.28	2.63	3.63	2.85	3.09	2.23
08N3(P)KMg	5.56	4.25	3.34	4.20	3.63	3.83	2.98
09N4(P)KMg	6.14	5.42	4.37	4.96	4.89	4.75	4.66
10N4	4.82	3.56	2.16	2.04	1.49	1.59	1.35
11N4PMg	3.92	3.28	2.07	2.35	1.96	1.94	2.41
12N1+3+1(P)K2Mg2	6.03	5.86	5.30	5.55	5.24	5.26	4.57
13N4PK	5.11	4.02	3.25	4.29	4.27	4.45	3.35
14N4PK*(Mg*)	5.37	4.06	3.42	4.56	4.95	4.74	3.97
15N5(P)KMg	6.44	4.93	4.97	4.78	4.95	4.95	3.84
16N6(P)KMg	6.35	5.87	4.64	5.30	5.17	5.17	4.68
17N1+4+1PKMg	7.21	7.09	5.50	6.61	5.39	5.07	5.49
18N1+2+1PKMg	6.47	6.51	4.96	6.16	4.93	3.67	4.70
19N1+1+1KMg	4.26	4.04	4.34	4.28	4.46	2.72	4.12
20N4KMg	*	*	*	*	1.30	*	1.39

GRAIN MEAN DM% 83.4

STRAW TONNES/HECTARE

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

SECTION / PLOT	4/W1	6/W24	1/W35	9/W43
01(FYM)N4	3.01	2.31	*	*
21FYMN2	2.58	2.31	3.63	3.17
22FYM	1.11	0.78	1.87	1.70
03Nil	0.20	0.41	0.47	0.25
05(P)KMg	0.66	0.18	0.45	0.31
06N1(P)KMg	1.85	1.82	2.22	1.92
07N2(P)KMg	2.62	1.90	2.33	1.88
08N3(P)KMg	3.13	1.94	2.78	2.45
09N4(P)KMg	3.52	1.88	2.85	2.87
10N4	2.27	1.04	0.94	1.08
11N4PMg	1.55	1.39	1.39	1.40
12N1+3+1(P)K2Mg2	3.47	3.18	3.32	2.63
13N4PK	2.92	2.05	2.86	2.38
14N4PK*(Mg*)	2.95	2.37	2.84	2.15
15N5(P)KMg	4.01	2.74	2.80	2.43
16N6(P)KMg	3.62	2.85	3.18	2.65
17N1+4+1PKMg	4.23	3.70	4.11	2.87
18N1+2+1PKMg	3.74	3.70	3.83	1.81
19N1+1+1KMg	2.75	2.63	2.83	1.52
20N4KMg	*	*	0.97	*

STRAW MEAN DM% 84.8

01/R/BK/1 S. OATS

GRAIN TONNES/HECTARE

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

PLOT	GRAIN	STRAW
01(FYM)[N4]	3.79	2.12
21[FYMN2]	4.06	2.15
22[FYM]	3.62	1.62
03Nil	1.64	0.58
05(P)KMg	1.83	0.84
06[N1](P)KMg	2.46	1.12
07[N2](P)KMg	2.66	1.23
08[N3](P)KMg	2.86	1.42
09[N4](P)KMg	3.01	1.52
10[N2]	1.50	0.56
11[N2]PMg	2.23	0.98
12[N2](P)K2Mg2	1.97	0.93
13[N2]PK	1.83	0.75
14[N2]PK*(Mg*)	2.19	0.92
15[N5](P)KMg	2.96	1.46
16[N6](P)KMg	3.56	1.52
17[N1+3]PKMg	3.11	1.50
18[N0+3]PKMg	3.29	1.49
19KMg	1.80	0.66

GRAIN MEAN DM% 86.1

STRAW MEAN DM% 69.3

MAIZE

WHOLE CROP (100% DM) TONNES/HECTARE

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

PLOT	WHOLE CROP
01(FYM)N4	13.67
21FYMN2	13.54
22FYM	9.43
03Nil	2.29
05(P)KMg	1.71
06N1(P)KMg	7.57
07N2(P)KMg	11.80
08N3(P)KMg	10.27
09N4(P)KMg	7.96
10N4	2.73
11N4PMg	4.11
12N2+3(P)K2Mg2	6.80
13N4PK	6.76
14N4PK*(Mg*)	8.84
15N5(P)KMg	6.43
16N6(P)KMg	7.76
17N2+4PKMg	6.45
18N2+2PKMg	7.42
19N2+1KMg	5.20

CROP MEAN DM% 20.8