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Results of the Classical and Other Long-term Experiments 2021

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Rothamsted Research

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21/R/PG/5 PARK GRASS

Object: To study the effects of organic manures and inorganic fertilisers and lime on old grass for hay.

The 166th year, hay.
For previous years see 'Details' 1977 and 1973 and Yield Books for 74-20/R/PG/5.

Treatments: Combinations of:

Whole plots

1. **Manure** Fertilizers and organic manures:

N1	Plot 1	N1
K	Plot 2/1	K since 1996 (as 2/2 before)
None (FYM)	Plot 2/2	None (FYM until 1863)
None	Plot 3	None
P	Plot 4/1	P
N2P	Plot 4/2	N2 P
N1PKNaMg	Plot 6	N1 P K Na Mg
(P)KNaMg	Plot 7/1	K Na Mg (+P until 2012)
PKNaMg	Plot 7/2	P K Na Mg
PNaMg	Plot 8	P Na Mg
PKNaMg(N2)	Plot 9/1	P K Na Mg (+ N2 until 1989)
N2PKNaMg	Plot 9/2	N2 P K Na Mg
N2PNaMg	Plot 10	N2 P Na Mg
N3PKNaMg	Plot 11/1	N3 P K Na Mg
N3PKNaMgSi	Plot 11/2	N3 P K Na Mg Si
None	Plot 12	None
(FYM/F)	Plot 13/1	None (FYM/F until 1993/1995)
FYM/PM	Plot 13/2	FYM/PM (FYM/F until 1999)
PKNaMg (N*2)	Plot 14/1	P K Na Mg (+ N*2 until 1989)
N*2PKNaMg	Plot 14/2	N*2 P K Na Mg
N*3PKNaMg (N*2)	Plot 15	N*3 P K Na Mg (N*2 until 1875; P K Na Mg 1876-2012)
N*1PKNaMg	Plot 16	N*1 P K Na Mg
N*1	Plot 17	N*1
N2KNaMg	Plot 18	N2 K Na Mg
FYM	Plot 19	FYM
FYM/N*PK	Plot 20	FYM/N*P K

N1, N2, N3:	48, 96, 144 kg N as sulphate of ammonia
N*1, N*2, N*3:	48, 96, 144 kg N as nitrate of soda (30 kg N to plot 20 in years with no FYM). In 2013 plot 15 started to receive 144 kg N as nitrate of soda to provide a comparison with plot 11/1, which receives 144 kg N as sulphate of ammonia.
P:	17 kg P applied as triple superphosphate since 2017, except for plot 20 which receives 15 kg P in years with no FYM. Prior to this, 35 kg P (15 kg P to plot 20 in years with no FYM) was applied as triple superphosphate in 1974 and since 1987, single superphosphate in other years.
(P):	In 2013 plot 7 was split into 7/1 & 7/2. P was withheld from plot 7/1 but 7/2 continues to receive P as above.
K:	225 kg K (45 kg K to plot 20 in years with no FYM) as sulphate of potash
Na:	15 kg Na as sulphate of soda
Mg:	10 kg Mg as sulphate of magnesia
Si:	Silicate of soda at 450 kg
FYM:	Farmyard manure at 35 t (fresh weight) every fourth year

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F:	Fishmeal every fourth year to supply 63 kg N (stopped 1999; replaced by PM)
PM	Pelleted poultry manure at 2 t (fresh weight), every fourth year to supply 63 kg N (started 2003)

Sub-plots

2.	**Lime**	**Liming plots 1-18 (excluding 18/2):**
a		Ground chalk applied as necessary to achieve pH7
b		Ground chalk applied as necessary to achieve pH6
c		Ground chalk applied as necessary to achieve pH5
d		None

NOTE: A small amount of chalk was applied to all plots during tests in the 1880s and 1890s. A regular test of liming was started in 1903 when most plots were divided in two and 4 t/ha $CaCO_3$ was applied every four years to the southern half. In 1965, most plots were divided into four: sub-plots "a" and "b" on the previously limed halves and sub-plots "c" and "d" on the unlimed halves. Sub-plots "a", "b" and "c" now receive different amounts of chalk, when necessary, to achieve and/or maintain soil (0-23 cm) at pH 7, 6 and 5, respectively. Sub-plot "d" receives no lime and its pH reflects inputs from the various treatments and the atmosphere. Lime was last applied in 2018; the ninth application in a triennial scheme of soil pH analysis and remedial chalk applications.

[This note was incorrect in earlier Yield book entries.]

NOTE: A separate scheme of liming was introduced on plots 18, 19 & 20 in 1920; subplot /1, /2 and /3 receive no lime, "high" lime and "light" lime respectively every 4 years. Since 1965 plot 18-1 has been split into two for treatments 'c' and 'd' as above and plot 18-3 split into two for treatments 'a' and 'b. Plots 19 and 20 received no further chalk after 1968; plot 18/2 no further chalk after 1972.

[This note was incorrect in earlier Yield book entries. See further details on the e-RA website at http://www.era.rothamsted.ac.uk]

Experimental Diary

Date		Application	Rate	Units
22/03/2021	f	Applied Chalk by hand: Plots 2/1c, 2/2a, 2/2b, 3b, 4/1b, 7/1c, 7/2c, 12/c, 13/1c, 13/2b, 15c	0.3	t/ha
22/03/2021	f	Applied Chalk by hand: Plots 3a, 8b, 9/1b, 9/1c, 14/1b, 15b	0.5	t/ha
22/03/2021	f	Applied Chalk by hand: Plots 1b, 1c, 2/1b, 4/2c, 7/1b, 7/2b, 10c, 12/b, 13/1b, 18/c	0.75	t/ha
22/03/2021	f	Applied Chalk by hand: Plot 4/2b	1	t/ha
22/03/2021	f	Applied Chalk by hand: Plot 10b	1.25	t/ha
22/03/2021	f	Applied Chalk by hand: Plots 2/1a, 9/1a, 9/2b, 11/1b, 11/1c, 11/2c, 18/b	1.5	t/ha
22/03/2021	f	Applied Chalk by hand: Plots 12/a, 13/1a, 17a	1.75	t/ha
22/03/2021	f	Applied Chalk by hand: Plots 1a, 4/1a, 9/2c, 11/2b, 13/2a, 14/1a, 14/2a	2	t/ha
22/03/2021	f	Applied Chalk by hand: Plots 6b, 7/1a, 7/2a, 8a, 9/2a, 10a, 15a, 16a	2.5	t/ha
22/03/2021	f	Applied Chalk by hand: Plots 11/2a	3	t/ha
22/03/2021	f	Applied Chalk by hand: Plot 6a	3.5	t/ha
22/03/2021	f	Applied Chalk by hand: Plots 4/2a, 11/1a, 18/a	4	t/ha

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06/04/2021	f	Applied TSP using Nordsten 3m fertiliser box, JD5070 : Plots 4/1, 4/2, 6, 7/2, 8, 9/1, 9/2, 10, 11/1, 11/2, 14/1, 14/2, 15, 16; Sub-plots a, b, c, d	83	kg/ha
09/04/2021	f	Applied SOP using Quick Pass, JD5070; Plots 2/1, 6, 7/1, 7/2, 9/1, 9/2, 11/1, 11/2, 14/1,14/2, 15, 16, 18; Sub-plots a, b, c, d	542	kg/ha
09/04/2021	f	Applied Silicate of Soda using Quick Pass, JD5070; Plot 11/2; Sub-plots a, b, c, d	450	kg/ha
09/04/2021	f	Applied Sulphate of Soda using Quick Pass, JD5070; Plots 6, 7/1, 7/2, 8, 9/1, 9/2, 10, 11/1, 11/2, 14/1,14/2, 15, 16, 18; Sub-plots a, b, c, d	43	kg/ha
09/04/2021	f	Applied Sulphate of Magnesia using Quick Pass, JD5070; Plots 6, 7/1, 7/2, 8, 9/1, 9/2, 10, 11/1, 11/2, 14/1,14/2, 15, 16, 18; Sub-plots a, b, c, d	111	kg/ha
13/04/2021	f	Applied Sulphate of Ammonia using Ransomes Nordsten Lift o-matic Fertiliser Box, JD5070: Plots 1 (Sub-plots a-d), 6a, 6b	229	kg/ha
13/04/2021	f	Applied Sulphate of Ammonia using Ransomes Nordsten Lift o-matic Fertiliser Box, JD5070: Plots 4/2, 9/2, 10, 18; Sub-plots a, b, c, d	457	kg/ha
13/04/2021	f	Applied Sulphate of Ammonia using Ransomes Nordsten Lift o-matic Fertiliser Box, JD5070: Plots 11/1, 11/2; Sub-plots a, b, c, d	686	kg/ha
12/04/2021	f	Applied Sodium Nitrate using Ransomes Nordsten Lift o-matic Fertiliser Box, JD5070: Plot 20	188	kg/ha
13/04/2021	f	Applied Sodium Nitrate using Ransomes Nordsten Lift o-matic Fertiliser Box, JD5070: Plot 16, 17; Sub-plots a, b, c, d	300	kg/ha
13/04/2021	f	Applied Sodium Nitrate using Ransomes Nordsten Lift o-matic Fertiliser Box, JD5070: Plot 14/2; Sub-plots a, b, c, d	600	kg/ha
13/04/2021	f	Applied Sodium Nitrate using Ransomes Nordsten Lift o-matic Fertiliser Box, JD5070: Plot 15; Sub-plots a, b, c, d	900	kg/ha
14/04/2021	f	Applied FYM using Muck spreader - international, Tym T503: Plots 13/2, 19, 20	35	t/ha
30/04/2021	a	Cut Paths using Kilworth Topper, Iseki ISTH4335	-	-
14/06/2021	a	Cut Paths using Kilworth Topper, Iseki ISTH4335	-	-
14-15/06/2021	a	Harvesting using Amazone Grass Harvester - Flail Mower Collector, JD5070 : Cut 1	-	-
14/07/2021	a	Mowing using JD6830, Kuhn Mower Conditioner	-	-
14/07/2021	a	Turning	-	-
08-09/11/2021	a	Harvesting using Amazone Grass Harvester - Flail Mower Collector, JD5070: Cut 2	-	-
16/11/2021	a	Rowing up using PZ Hay Rake, JD5070	-	-

NOTE: Samples of herbage (1st and 2nd Cut) were taken for chemical analysis. Unground herbage samples from all plots were archived.

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Yields

1ST CUT (14-15 JUN 2021) DRY MATTER, TONNES/HECTARE

Tables of means

Grand mean	**3.61**					
Manure	Lime	a	b	c	d	Mean
N1	1	2.67	2.57	2.15	1.56	2.24
K	2/1	2.88	2.50	2.13	1.74	2.31
None(FYM)	2/2	2.72	2.69	2.05	1.50	2.24
None	3	2.96	2.93	2.00	1.53	2.35
P	4/1	2.95	3.30	2.32	2.09	2.66
N2P	4/2	3.26	2.98	2.71	1.25	2.55
N1PKNaMg	6	5.28	4.65	-	-	4.96
(P)KNaMg	7/1	5.06	3.60	2.22	1.73	3.15
PKNaMg	7/2	6.15	4.72	2.51	1.94	3.83
PNaMg	8	2.56	3.52	2.39	2.00	2.62
PKNaMg(N2)	9/1	5.42	4.49	3.65	1.39	3.74
N2PKNaMg	9/2	6.40	6.14	5.27	2.40	5.05
N2PNaMg	10	4.26	4.15	3.58	1.53	3.38
N3PKNaMg	11/1	6.88	4.80	6.02	3.09	5.20
N3PKNaMgSi	11/2	6.35	4.98	5.66	3.81	5.20
None	12	2.66	2.12	2.07	2.69	2.38
(FYM/F)	13/1	2.60	3.19	3.06	2.71	2.89
FYM/PM	13/2	3.91	4.38	4.71	4.19	4.30
PKNaMg(N*2)	14/1	4.16	4.77	2.98	2.97	3.72
N*2PKNaMg	14/2	5.43	6.62	5.09	5.39	5.63
N*3PKNaMg(N*2)	15	7.94	6.53	5.41	4.92	6.20
N*1PKNaMg	16	5.21	5.38	4.51	4.26	4.84
N*1	17	2.76	2.53	2.00	2.09	2.34
N2KNaMg	18	2.87	2.46	1.93	1.74	2.25
N2KNaMg	18/2	-	-	-	-	2.68
FYM	19/1	-	-	-	-	4.51
FYM	19/2	-	-	-	-	4.48
FYM	19/3	-	-	-	-	4.12
FYM/N*PK	20/1	-	-	-	-	5.16
FYM/N*PK	20/2	-	-	-	-	4.90
FYM/N*PK	20/3	-	-	-	-	4.67

1st cut mean DM% 27.30

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2nd CUT (08-09 NOV 2021) DRY MATTER, TONNES/HECTARE

Tables of means

Grand mean	**2.42**					
Manure	Lime	a	b	c	d	Mean
N1 1		2.10	1.82	2.04	1.13	1.77
K 2/1		2.59	2.09	2.35	2.08	2.28
None(FYM) 2/2		2.58	2.79	2.69	1.49	2.39
None 3		2.18	2.35	2.32	1.97	2.21
P 4/1		2.78	2.57	2.25	2.09	2.42
N2P 4/2		1.98	1.83	2.13	1.62	1.89
N1PKNaMg 6		2.09	1.75	-	-	1.92
(P)KNaMg 7/1		2.64	2.47	2.25	1.95	2.33
PKNaMg 7/2		2.43	2.73	2.72	2.04	2.48
PNaMg 8		2.37	2.71	2.95	2.04	2.52
PKNaMg(N2) 9/1		2.69	3.11	2.70	1.13	2.41
N2PKNaMg 9/2		2.42	2.62	2.51	2.26	2.45
N2PNaMg 10		2.00	1.95	2.91	2.11	2.24
N3PKNaMg 11/1		2.98	2.82	2.46	3.65	2.98
N3PKNaMgSi 11/2		3.57	3.04	2.26	3.12	3.00
None 12		2.32	1.97	2.73	2.43	2.36
(FYM/F) 13/1		2.65	3.17	2.82	2.61	2.81
FYM/PM 13/2		2.08	3.19	3.11	2.99	2.85
PKNaMg(N2*) 14/1		2.50	2.80	2.25	2.34	2.47
N*2PKNaMg 14/2		2.55	3.11	2.60	2.36	2.65
N*3PKNaMg(N*2) 15		2.19	3.04	3.07	2.31	2.65
N*1PKNaMg 16		2.19	2.97	2.68	1.78	2.40
N*1 17		2.35	1.86	2.52	1.71	2.11
N2KNaMg 18		2.45	2.26	1.81	1.16	1.92
N2KNaMg 18/2		-	-	-	-	2.25
FYM 19/1		-	-	-	-	2.79
FYM 19/2		-	-	-	-	3.27
FYM 19/3		-	-	-	-	2.85
FYM/N*PK 20/1		-	-	-	-	2.00
FYM/N*PK 20/2		-	-	-	-	3.03
FYM/N*PK 20/3		-	-	-	-	2.40

1st cut mean DM% 28.08

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TOTAL OF 2 CUTS DRY MATTER, TONNES/HECTARE

Tables of means

Grand mean	**6.02**					
Manure	Lime	a	b	c	d	Mean
N1	1	4.77	4.39	4.19	2.69	4.01
K	2/1	5.47	4.59	4.48	3.81	4.59
None(FYM)	2/2	5.30	5.48	4.74	2.99	4.62
None	3	5.14	5.28	4.32	3.50	4.56
P	4/1	5.72	5.87	4.57	4.18	5.09
N2P	4/2	5.23	4.81	4.84	2.87	4.44
N1PKNaMg	6	7.37	6.40	-	-	6.89
(P)KNaMg	7/1	7.70	6.07	4.47	3.68	5.48
PKNaMg	7/2	8.59	7.45	5.23	3.98	6.31
PNaMg	8	4.93	6.23	5.33	4.04	5.13
PKNaMg(N2)	9/1	8.11	7.60	6.34	2.52	6.14
N2PKNaMg	9/2	8.82	8.75	7.78	4.66	7.50
N2PNaMg	10	6.26	6.10	6.49	3.64	5.62
N3PKNaMg	11/1	9.86	7.63	8.48	6.74	8.18
N3PKNaMgSi	11/2	9.93	8.02	7.91	6.93	8.20
None	12	4.99	4.09	4.79	5.12	4.75
(FYM/F)	13/1	5.26	6.36	5.88	5.32	5.70
FYM/PM	13/2	5.99	7.57	7.83	7.18	7.14
PKNaMg(N*2)	14/1	6.66	7.56	5.23	5.32	6.19
N*2PKNaMg	14/2	7.98	9.72	7.69	7.75	8.28
N*3PKNaMg(N*2)	15	10.14	9.57	8.48	7.23	8.85
N*1PKNaMg	16	7.39	8.35	7.19	6.04	7.24
N*1	17	5.10	4.39	4.53	3.80	4.45
N2KNaMg	18	5.32	4.72	3.74	2.90	4.17
N2KNaMg	18/2	-	-	-	-	4.93
FYM	19/1	-	-	-	-	7.30
FYM	19/2	-	-	-	-	7.75
FYM	19/3	-	-	-	-	6.97
FYM/N*PK	20/1	-	-	-	-	7.16
FYM/N*PK	20/2	-	-	-	-	7.93
FYM/N*PK	20/3	-	-	-	-	7.07

1st cut mean DM% 27.69

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