Results of the Classical and Other Long-term Experiments 2022

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22/R/PG/5 - Park Grass

Rothamsted Research

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22/R/PG/5 PARK GRASS

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

The 167th year, hay.
For previous years see 'Details' 1977 and 1973 and Yield Books for 74-21/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*P*K*	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 (Epsom Salts)
Si:	Silicate of soda at 450 kg
FYM:	Farmyard manure at 35 t (fresh weight) every fourth year; last applied 2021
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); last applied 2019

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 2021; the tenth 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
23/11/2021	f	Applied using Ransomes Nordsten Lift o-matic Fertiliser Box, JD5070: Sulphate of Potash (SOP): All K Plots except 20	542	kg/ha
23/11/2021	f	Applied using Ransomes Nordsten Lift o-matic Fertiliser Box, JD5070: Sulphate of Potash (SOP): Plot 20 only	108	kg/ha
23/11/2021	f	Applied using Ransomes Nordsten Lift o-matic Fertiliser Box, JD5070: sulphate of magnesia (Epsom Salts)	111	kg/ha
23/11/2021	f	Applied using Ransomes Nordsten Lift o-matic Fertiliser Box, JD5070: Sulphate of Soda	43	kg/ha
23/11/2021	f	Applied using Ransomes Nordsten Lift o-matic Fertiliser Box, JD5070: Silicate of Soda	450	kg/ha
25/11/2021	f	Applied using Ransomes Nordsten Lift o-matic Fertiliser Box, JD5070: Triple Super Phosphate (TSP): All P plots except 20	83	kg/ha
25/11/2021	f	Applied using Ransomes Nordsten Lift o-matic Fertiliser Box, JD5070: Triple Super Phosphate (TSP): Plot 20 only	73	kg/ha
23/05/2022	f	Applied using Nordsten 3m fertiliser box, JD5070: Sulphate of Ammonia: Plots 1, 6 (a + b only)	229	kg/ha
23/05/2022	f	Applied using Nordsten 3m fertiliser box, JD5070: Sulphate of Ammonia: Plots 4/2, 9/2, 10, 18	457	kg/ha
23/05/2022	f	Applied using Nordsten 3m fertiliser box, JD5070: Sulphate of Ammonia: Plots 11/1, 11/2	686	kg/ha
23/05/2022	f	Applied using by Hand, JD5070: Sodium Nitrate: Plots 20	188	kg/ha
23/05/2022	f	Applied using by Hand, JD5070: Sodium Nitrate: Plots 16, 17	300	kg/ha
23/05/2022	f	Applied using by Hand, JD5070: Sodium Nitrate: Plots 14/2	600	kg/ha
23/05/2022	f	Applied using by Hand, JD5070: Sodium Nitrate: Plots 15	900	kg/ha
14/06/2022 to 15/06/2022	a	Harvest using Amazone Grass Harvester - Flail Mower Collector, JD5070: Mowing - 1st Cut Started	-	-
31/10/2022	a	Topped using Kilworth Topper, Iseki ISTH4335:Paths and Surrounds	-	-
05/12/2022	a	Harvest using Amazone Grass Harvester - Flail Mower Collector: Park Grass 2nd Cut 2022	-	-
05/12/2022	a	Mowed using McHale Pro Glide R3100, JD6145R Premium: Extras and surrounds	-	-
06/12/2022	a	Rowed up using Claas Windrower, JD6145R Premium	-	-
07/12/2022	a	Baled using McHale Fusion 2 Baler, JD6145R Premium	-	-

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

Yields

1st CUT (14-15 JUN 2022) DRY MATTER, TONNES/HECTARE

Tables of means

Grand mean		3.36					
Manure		Lime	a	b	c	d	Mean
N1	1		2.46	1.87	1.26	[a] 2.98	**2.14**
K	2/1		1.32	2.21	1.65	1.66	**1.71**
None(FYM)	2/2		2.60	2.54	2.11	1.52	**2.19**
None	3		3.37	2.45	2.00	1.76	**2.39**
P	4/1		3.51	3.50	2.72	1.91	**2.91**
N2P	4/2		2.80	2.37	2.56	1.91	**2.41**
N1PKNaMg	6		4.45	4.81	-	-	**4.63**
(P)KNaMg	7/1		5.87	4.40	1.57	1.44	**3.32**
PKNaMg	7/2		4.78	3.92	1.77	1.33	**2.95**
PNaMg	8		2.95	3.19	1.61	1.93	**2.42**
PKNaMg(N2)	9/1		3.73	4.87	3.90	1.34	**3.46**
N2PKNaMg	9/2		4.65	3.00	3.16	3.21	**3.51**
N2PNaMg	10		2.92	2.84	3.45	2.21	**2.85**
N3PKNaMg	11/1		5.68	6.50	4.93	3.52	**5.16**
N3PKNaMgSi	11/2		6.38	5.32	5.85	2.44	**5.00**
None	12		2.53	2.16	2.12	1.96	**2.19**
(FYM/F)	13/1		3.09	3.51	2.86	2.90	**3.09**
FYM/PM	13/2		4.08	4.74	5.01	4.02	**4.46**
PKNaMg(N2*)	14/1		5.77	5.56	2.11	3.13	**4.14**
N2*PKNaMg	14/2		4.88	5.66	5.68	4.14	**5.09**
N3*PKNaMg(N2*)	15		6.39	5.70	6.53	4.98	**5.90**
N1*PKNaMg	16		4.23	4.71	3.38	2.33	**3.66**
N1*	17		2.49	2.32	2.12	2.08	**2.25**
N2KNaMg	18		2.14	1.88	1.40	1.47	**1.72**
N2KNaMg	18/2		-	-	-	-	**2.09**
FYM	19/1		-	-	-	-	**5.28**
FYM	19/2		-	-	-	-	**4.74**
FYM	19/3		-	-	-	-	**4.61**
FYM/N*PK	20/1		-	-	-	-	**5.06**
FYM/N*PK	20/2		-	-	-	-	**4.90**
FYM/N*PK	20/3		-	-	-	-	**4.37**

1st cut mean DM% 31.9

Notes

[a] There is some uncertainty to whether the yield given for subplot 1d is correct as it is unusually high compared to other plot 1 subplots, which are usually higher due to liming treatment.

2nd CUT (02, 05, 06 DEC 2022) DRY MATTER, TONNES/HECTARE

Tables of means

Grand mean		**1.33**					
Manure		**Lime**	**a**	**b**	**c**	**d**	**Mean**
N1	1		0.84	0.47	0.68	0.28	**0.57**
K	2/1		1.23	0.61	0.57	0.42	**0.71**
None(FYM)	2/2		1.11	0.38	0.61	0.81	**0.73**
None	3		0.89	0.63	0.84	0.71	**0.77**
P	4/1		[a] 1.17	0.91	1.12	1.40	**1.15**
N2P	4/2		1.69	1.95	1.04	1.07	**1.44**
N1PKNaMg	6		1.66	1.75	-	-	**1.71**
(P)KNaMg	7/1		2.27	1.89	1.23	0.73	**1.53**
PKNaMg	7/2		2.11	1.77	1.41	0.84	**1.54**
PNaMg	8		0.85	1.03	1.17	1.13	**1.05**
PKNaMg(N2)	9/1		1.44	1.31	0.80	0.30	**0.96**
N2PKNaMg	9/2		1.99	1.90	1.14	0.98	**1.50**
N2PNaMg	10		[a] 0.97	0.95	0.91	1.04	**0.97**
N3PKNaMg	11/1		1.06	[a] 1.89	[a] 2.07	2.15	**1.79**
N3PKNaMgSi	11/2		0.69	1.21	1.51	1.66	**1.27**
None	12		0.87	0.61	0.51	0.80	**0.70**
(FYM/F)	13/1		[a] 1.65	[a] 1.32	1.28	0.99	**1.31**
FYM/PM	13/2		1.69	1.97	1.70	1.43	**1.70**
PKNaMg(N2*)	14/1		1.86	1.54	1.29	*	**1.56**
N2*PKNaMg	14/2		1.61	2.16	2.51	2.11	**2.09**
N3*PKNaMg(N2*)	15		2.12	1.78	2.19	1.43	**1.88**
N1*PKNaMg	16		2.12	2.20	[a] 1.46	[a] 1.56	**1.84**
N1*	17		[a] 0.92	1.31	1.42	0.84	**1.12**
N2KNaMg	18		[a] 1.95	[a] 1.06	0.68	0.46	**1.04**
N2KNaMg	18/2		-	-	-	-	**0.67**
FYM	19/1		-	-	-	-	[a] **2.30**
FYM	19/2		-	-	-	-	**2.24**
FYM	19/3		-	-	-	-	**2.52**
FYM/N*PK	20/1		-	-	-	-	**2.06**
FYM/N*PK	20/2		-	-	-	-	**2.34**
FYM/N*PK	20/3		-	-	-	-	**2.26**

2nd cut mean DM% 17.85

Notes

[a] The 2nd cut yields for 12 subplots (4/1a, 10a, 11/1b, 11/1c, 13/1a, 13/1b, 16c, 16d, 17a, 18a, 18b, 19/1) are based on one within-plot cut strip only, rather than the usual two, due to the harvest machine jamming a number of times, likely due to the wet conditions. This has been accounted for in calculating the conversion factor from kg to tonnes/hectare (i.e., harvest area halved).

* Missing 2nd cut yields for plot 14/1d as this subplot has only one within-plot cut strip ordinarily.

TOTAL OF 2 CUTS DRY MATTER, TONNES/HECTARE

Tables of means

Grand mean		**4.70**					
Manure	**Lime**		**a**	**b**	**c**	**d**	**Mean**
N1	1		3.30	2.34	1.94	3.26	**2.71**
K	2/1		2.55	2.81	2.22	2.08	**2.42**
None(FYM)	2/2		3.72	2.92	2.72	2.33	**2.92**
None	3		4.26	3.08	2.84	2.47	**3.16**
P	4/1		[a] 4.67	4.41	3.84	3.31	**4.06**
N2P	4/2		4.48	4.32	3.60	2.98	**3.84**
N1PKNaMg	6		6.12	6.57	-	-	**6.34**
(P)KNaMg	7/1		8.14	6.30	2.79	2.16	**4.85**
PKNaMg	7/2		6.89	5.70	3.18	2.18	**4.49**
PNaMg	8		3.80	4.22	2.78	3.06	**3.47**
PKNaMg(N2)	9/1		5.18	6.18	4.70	1.65	**4.43**
N2PKNaMg	9/2		6.64	4.90	4.30	4.19	**5.00**
N2PNaMg	10		[a] 3.90	3.79	4.36	3.24	**3.82**
N3PKNaMg	11/1		6.74	[a] 8.39	[a] 7.00	5.67	**6.95**
N3PKNaMgSi	11/2		7.07	6.53	7.36	4.10	**6.26**
None	12		3.40	2.77	2.62	2.76	**2.89**
(FYM/F)	13/1		[a] 4.74	[a] 4.83	4.14	3.89	**4.40**
FYM/PM	13/2		5.76	6.71	6.71	5.45	**6.16**
PKNaMg(N2*)	14/1		7.63	7.11	3.39	*	**6.04**
N2*PKNaMg	14/2		6.48	7.81	8.19	6.25	**7.18**
N3*PKNaMg(N2*)	15		8.51	7.49	8.72	6.41	**7.78**
N1*PKNaMg	16		6.36	6.91	[a] 4.83	[a] 3.90	**5.50**
N1*	17		[a] 3.41	3.63	3.54	2.92	**3.37**
N2KNaMg	18		[a] 4.09	[a] 2.94	2.07	1.92	**2.76**
N2KNaMg	18/2		-	-	-	-	**2.77**
FYM	19/1		-	-	-	-	[a] **7.57**
FYM	19/2		-	-	-	-	**6.98**
FYM	19/3		-	-	-	-	**7.13**
FYM/N*PK	20/1		-	-	-	-	**7.12**
FYM/N*PK	20/2		-	-	-	-	**7.24**
FYM/N*PK	20/3		-	-	-	-	**6.62**
Total of 2 cuts mean DM%		**24.89**					

Notes

[a] Combined 2 cuts yield for 12 subplots (4/1a, 10a, 11/1b, 11/1c, 13/1a, 13/1b, 16c, 16d, 17a, 18a, 18b, 19/1) are based on three within-plot cut strips only, rather than the usual four, due to issues with the 2nd cut (see 2nd cut notes above). This has been accounted for in calculating the conversion factor from kg to tonnes/hectare.

* Missing combined 2 cuts yield for plot 14/1d as 2nd cut yield was missing (see 2nd cut notes above).