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Exhaustion Land Spring Barley

Rothamsted Research

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TABLE 4
Mean yield (4 years, 1980-83) of Georgie spring barley grain t ha⁻¹

Continuous barley since fallow in 1967				
	N0	N1	N2	N3
-	0.8	1.2	1.5	1.6
P	1.9	3.0	3.0	2.5
K	1.0	1.6	2.0	2.1
PK	1.7	3.6	4.5	5.1
FYM	5.0	5.6	5.3	5.8

	After continuous barley 1968-79		After barley in rotation 1968-79	
	-	(S)-	(-)S	(S)S
N3-	1.5	3.2	3.3	3.8
N3P	3.6	4.5	5.2	5.3
N3K	2.3	4.3	4.0	4.6
N3PK	5.3	6.0	5.6	5.6

Forms of nitrogen have not been tested since 1967, PKMg applications on the old rape cake series were discontinued after 1979 and the silicate of soda test was modified in 1980 to include the four combinations of:

- (1) 0 vs silicate from 1980
- (2) 0 vs silicate 1862-1979

Recent yields (Table 4) continue to show the great importance of P to spring-sown barley as well as large positive interactions between N, P and K. Although the yields from complete fertilizers match the yields from FYM alone, the largest yields, as on Broadbalk, come from the combination of FYM and nitrogen fertilizer. The residual effect of silicate of soda applied until 1979 more than doubled the yield of plots given nitrogen alone and even when P is supplied the effect is considerable. Fresh or continued dressings of silicate since 1979 appear also to be beneficial but at present these effects are uncertain because of differences in the continuity of barley cropping.

EXHAUSTION LAND SPRING BARLEY

This area was cropped with wheat without manure from 1850 to 1855 when it was divided into four strips for a fertilizer test with continuous wheat given treatments similar to some of those on Broadbalk. This continued until 1875; potatoes were then grown from 1876 to 1901 with an additional strip added and all five strips halved to test ten manurial treatments repeated on the plots each year. Three of these treatments were the same as those applied to the same plots under wheat.

Table 5 shows the number of annual dressings given to these plots between 1856 and 1901 and estimates of the total amounts of P and K applied in FYM and fertilizers.

The potato experiment ended in 1901 and with few exceptions cereals have been grown each year since then. From 1902 to 1939 no manures were given; yields of grain and straw recorded in some of the earlier years measured the residual values of the manures applied to the potatoes. From 1940 fertilizer

TABLE 5
Number of annual-dressings applied 1856-1901 and estimated amounts of P and K applied in FYM and fertilizer

	Plot number									
	1	2	3	4	5	6	7	8	9	10
	Number of dressings									
FYM	—	6	26	26	—	—	—	—	—	—
PK	—	—	—	—	—	—	42	42	17	42
P only	—	—	7	7	—	—	—	—	25	—
N	—	—	—	6	43	43	43	43	—	—
	Nutrients applied (kg ha ⁻¹)									
P	0	235	1260	1260	0	0	1410	1410	1410	1410
K	0	900	3920	3920	0	0	5040	5040	1570	5040

TABLE 6
Mean yields of barley 1949-83 and recent soil analyses

Period	N kg ha ⁻¹	Variety	Plots	Plots 7, 8	Plots 3, 4
			1, 2, 5, 6 no P, no K	residues of PK fertilizers 1856-1901	residues of FYM 1876-1901
Mean yields of grain, t ha ⁻¹					
1949-63	63	Plumage Archer	1.8	2.9	3.2
1964-69	88	Maris Badger	1.7	3.6	4.3
1970-75	88	Julia	1.8	4.2	4.8
1976-79	$\left\{ \begin{array}{l} 0 \\ 48 \\ 96 \\ 144 \end{array} \right\}$	Julia	0.9	1.6	2.1
			1.3	2.9	3.5
			1.4	3.0	4.0
			1.6	3.1	3.8
1980-83	$\left\{ \begin{array}{l} 0 \\ 48 \\ 96 \\ 144 \end{array} \right\}$	Georgie	0.7	1.5	2.3
			1.1	2.2	3.2
			1.1	2.7	3.8
			1.2	2.8	3.8
Nutrients in air-dry soil and year of sampling					
N%		1974	0.102	0.100	0.124
P soluble in 0.5M-NaHCO ₃ mg kg ⁻¹	$\left\{ \begin{array}{l} 1951 \\ 1965 \\ 1974 \\ 1981 \end{array} \right\}$	7	21	27	
		6	12	18	
		2	8	12	
		2	6	10	
K soluble in M-ammonium acetate, mg kg ⁻¹	$\left\{ \begin{array}{l} 1951 \\ 1965 \\ 1974 \\ 1981 \end{array} \right\}$	74	121	106	
		88	122	114	
		69	89	87	
		66	85	81	

nitrogen has been given each year; this increased yields, which have been recorded since 1949, and accentuated the visual effects of the former manuring. From 1976 fertilizer N has been tested at four rates (0, 48, 96, 144 kg N ha⁻¹) on sub-plots.

Table 6 shows N rates, varieties and yields from 1949-83 and some soil analyses during this period. The introduction of new varieties from 1964 to

1975, together with an increase in nitrogen rate considerably increased yields on plots with residues but gave no improvement on plots without. Since then, despite the inclusion of larger nitrogen rates and probably as a result of continued depletion of P and K, yields have generally declined on all plots. The decline has been less on plots with FYM residues, supporting the view that the prolonged residual effects in this experiment are primarily those of P.

During the 40 years, 1901–40, when no N was applied, crops made little use of the P and K residues in the soil. However, these residues must have remained in available forms because for the next 40 years they increased yields to twice those on unmanured plots and these larger yields equalled the national average for spring barley.

PARK GRASS

The Park Grass experiment, laid down in 1856, is much the oldest on grassland in Great Britain. The field had been in grass for at least a century when the experiment began. It demonstrates in a unique way how continued manuring with different fertilizers affects both the botanical composition and the yield of a mixed population of grasses, clovers and weeds. After more than 100 years, the boundaries of the plots are still clearly defined; the transition between adjacent treatments occupies 30 cm or less, showing that there is little sideways movement of nutrients in undisturbed soil.

The plots have been cut each year for hay, all at the same time, although no single date can be suitable for all plots. For a few years the aftermath was grazed by sheep, penned on each plot and their weight increases recorded but from 1873 the second cut has been weighed and carted green. Since 1960 yields, corrected to dry matter, have been calculated from the weights of produce from sample strips cut with a forage harvester (two per plot). At the first cutting the produce of the remainder of each plot is made into hay; this allows the return of

Park Grass (see plan on opposite page)

Treatments (every year except as indicated)

Nitrogen (applied in spring)

N1, N2, N3 sulphate of ammonia supplying 48, 96, 144 kg N ha⁻¹ (about 0.4, 0.8, 1.2 cwt N acre⁻¹)

N1*, N2* nitrate of soda supplying 48, 96 kg N ha⁻¹ (about 0.4, 0.8 cwt N acre⁻¹)

Minerals (applied in winter)

P 35 kg P ha⁻¹ as granular superphosphate (19% P₂O₅) (0.6 cwt P₂O₅ acre⁻¹)

K 225 kg K ha⁻¹ as sulphate of potash (50% K₂O) (2.2 cwt K₂O acre⁻¹)

Na 15 kg Na ha⁻¹ as sulphate of soda (14% Na)

Mg 10 kg Mg ha⁻¹ as sulphate of magnesia (10% Mg)

Silicate of soda at 450 kg ha⁻¹ of water soluble powder (plot 11/2)

Plot 20. Rates of manuring in years when FYM not applied:

30 kg N, 15 kg P, 45 kg K ha⁻¹

Organics (each applied every fourth year)

FYM 35 t ha⁻¹ farmyard manure (bullocks) (1985, 1989) (14 tons acre⁻¹)

Fish meal (about 6.5% N) to supply 63 kg N ha⁻¹ (1983, 1987) (about 950 kg ha⁻¹ meal or 850 lb acre⁻¹)