ROTHAMSTED RESEARCH

Report for 1979 - Part 1

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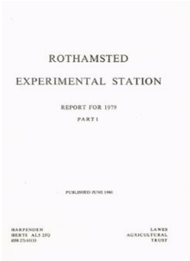

Field Experiments Section

G. V. Dyke

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FIELD EXPERIMENTS SECTION

G. V. DYKE

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Introduction

The primary task of the Section is to ensure the efficient planning and execution of field experiments. To this end we did the secretarial work of the Field Plots Committee and its many Working Parties etc; we provided detailed plans of all experiments based on the Committee's decisions; we helped sponsors to formulate proposals for experiments in practical form and in consultation with the Head of Farms, advised sponsors on the day-to-day progress of their experiments. Some of the more specialised experiments were done by the Small-plot Staff of the Section. We made notes on the crops on the plots in mid-season and helped the Statistics Department to prepare for publication the *Yields of the Field Experiments*. (Mainly McEwen, Barnard, Finch and Jones)

Secondly, we received and guided most of the 3000 visitors who came to Rothamsted (in addition to those who attended Subject Days on potatoes). Most of them saw something of the Classical experiments and in 1979 many examined also the winter wheat experiment (Factors Limiting Yield) in West Barnfield, on which the crop looked excellent throughout and yielded exceptionally well (see p. 17). (Parker, with help from other members of the Section)

Field Plots Committee

The Committee (F. G. W. Jones, Chairman; R. N. Bradfer-Lawrence, L. Fowden, I. J. Graham-Bryce, A. E. Johnston, E. Lester, T. Lewis, R. Moffitt, J. A. Nelder, P. B. Tinker, C. P. Whittingham and T. Woodhead, with Dyke and McEwen as secretaries) controls the field experiments on both farms. In 1979 the main Committee and its Working Parties, Commodity Groups etc, met formally on 27 occasions; many tours of the experiments by Commodity Groups allowed less formal and often very productive discussions. The present organisation was devised in 1977 by F. G. W. Jones who retired in November. He joined the Committee in 1965 and took the Chair in 1975. I. J. Graham-Bryce, a member since 1973, resigned in 1979 on leaving Rothamsted.

The number of plots in the various categories in 1979 (Table 1) were not much different from those of 1978. The grand total increased by 244, mainly because there were more microplots.

Small-plot Experiments

The Small-plot staff provided sites, equipment and help to those sponsors whose experiments could not readily be adapted to methods and machinery used by the Farm. This

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TABLE 1

Number of plots in 1979

	Grain	Roots	Hay and green crops	Total
Full-scale plots (yields taken)				
Classical experiments				
Rothamsted	358	19	237	614
Saxmundham	280	—	100	380
Long-period rotation experiments				
Rothamsted	84	64	122	270
Woburn	368	96	76	540
Crop sequence experiments				
Rothamsted	651	32	479	1162
Woburn	286	284	—	570
Saxmundam	80	—	—	80
Annual experiments				
Rothamsted	1608	288	60	1956
Woburn	419	80	—	499
Saxmundham	46	—	—	46
Totals				
Rothamsted	2701	403	898	4002
Woburn	1073	460	76	1609
Saxmunham	406	—	100	506
Total	4180	863	1074	6117
Full-scale plots (no yields taken)				
Rothamsted				733
Woburn				86
Microplots				
Rothamsted				2060
Woburn				639
All plots total				9635

year they did all operations on 46 experiments (1509 plots) and some operations on 22 others (886 plots). Because of increasing pressure on the land available in the Garden Plots and Long Hoos IV–VII, an additional area has been allocated for Small-plot work in Long Hoos III. This will allow some (possibility not enough) periods of 'rest' to eliminate disturbing effects of previous experiments on later ones. A problem of particular difficulty in autumn 1979 has been the increased requirement to apply sprays to winter cereals in the autumn when (especially this year) the ground is too wet to carry wheels or even feet without marked ill effects. (Wilson, with Jones, Martin-Smith, Turnell and Haggis)

The Classical Experiments

On Broadbalk Flanders wheat replaced Cappelle-Desprez, grown for ten seasons. A fungicide spray (triadimefon) was applied to control leaf diseases, mainly mildew, and this will be done as a routine in future; an aphicide will also be used if necessary (not applied in 1979). With these changes, and an early sowing (10 October) yields, except on poorly-manured plots, were outstandingly good (Table 2). With farmyard manure, 96 kg ha^{-1} fertiliser N with P and K at standard rates (plot 1, this treatment began in 1968) the yield of grain after beans was 8·7 t ha^{-1} (69·5 cwt acre^{-1}), the best ever recorded on the experiment.

Yields of spring barley on the Permanent Barley experiment in Hoosfield were on average about equal to those of 1978, about 0·6 t ha^{-1} less than in 1977.

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TABLE 2

Broadbalk (BK) and Hoos Barley (HB): Yields of crops from selected treatments

Grain at 85% dry matter, t ha⁻¹ and total tubers, t ha⁻¹

Treatments		Wheat after potatoes, beans 1979	1978	1977	Barley 1979	1978	1977	Potatoes 1979	1978	1977
None	BK	2·6	3·2	2·5	—	—	—	6·1	11·1	7·0
	HB*	—	—	—	1·7	3·3	2·2	—	16·5	9·8
	HB†	—	—	—	0·9	1·0	1·7	—	—	—
N3PKMg(Na)	BK	7·3	6·8	5·6	—	—	—	30·0	38·3	26·1
	HB*	—	—	—	5·6	5·7	6·1	—	—	—
	HB†	—	—	—	4·6	5·3	5·9	—	—	—
N4PKMg(Na)	BK	7·6	6·4	5·8	—	—	—	31·1	48·4	34·9
	HB*	—	—	—	—	—	—	—	43·7	43·7
FYM	BK	6·9	7·9	5·2	—	—	—	24·0	32·6	26·9
	HB†	—	—	—	3·3	5·1	5·2	—	—	—
FYM+N2	BK	8·3	8·0	5·8	—	—	—	29·7	40·1	30·2
	HB†	—	—	—	5·8	5·6	6·5	—	—	—
FYM+N2PK (since 1968)	BK	8·7	7·8	5·7	—	—	—			
							Date of planting	14/5	9/5	19/4

* With residues of castor meal, crops in rotation barley, potatoes, beans
† After barley, no castor meal
Symbols: N2, N3, N4 = 'Nitro-Chalk' at 96, 144, 192 kg N ha⁻¹
P = Superphosphate annually, at 35 kg P ha⁻¹
K = Sulphate of potash annually, at 90 kg K ha⁻¹
Mg = Kieserite applied at 35 kg Mg ha⁻¹ every third year
(Na) = Sulphate of soda annually until 1973
FYM = Farmyard manure annually, at 35 t ha⁻¹

Effects of silicate on Hoos Barley. The termination in 1978 of the rotation of crops (started on part of the experiment in 1968) will allow a changed test of silicate of soda in 1980; meanwhile a brief summary of recent effects is presented. Silicate has been applied annually since 1862, at first as equal weights of sodium silicate and calcium silicate, since 1868 sodium silicate alone, at 448 kg ha⁻¹. It has increased the yield of barley in every decade of the experiment (*Rothamsted Report for 1966*, 320–338).

TABLE 3

Hoos Barley, effects of silicate of soda on barley, grain at 85% dry matter, t ha⁻¹

Treatment since 1852	Mean yields 1868–1966* None	Si	1968–79† None	Si	Increases for silicate 1968–79†: N, kg ha⁻¹, annually 0	48	96	144	Mean increase
None	1·54	1·95	1·92	3·36	+0·52	+1·62	+1·85	+1·74	+1·44
P	2·49	2·59	3·51	4·02	−0·02	+0·43	+0·65	+1·00	+0·51
KMg(Na)	1·63	2·05	2·41	3·72	+0·50	+0·97	+1·69	+2·06	+1·31
PKMg(Na)	2·47	2·66	3·91	4·23	+0·34	+0·31	+0·38	+0·24	+0·32
Mean	2·03	2·31	2·94	3·83	+0·34	+0·83	+1·14	+1·26	+0·89

* Omitting 1912, 1933, 1943 (fallow) and 1953 (no yields recorded)
† Continuous barley since fallow 1967
Symbols: Si Sodium silicate at 448 kg ha⁻¹ annually (sodium silicate at 224 and calcium silicate at 224 kg ha⁻¹ 1862–67)
P Superphosphate at 35 kg P ha⁻¹ annually
K Potassium sulphate at 90 kg K ha⁻¹ annually
Mg Kieserite at 35 kg Mg ha⁻¹ every third year
(Na) Sodium sulphate at 15 kg Na ha⁻¹ annually until 1973, none since

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Since the changes introduced in 1968 effects of silicate have been markedly greater; more than in proportion to the general increase in yield (Table 3). On land not given P silicate gave on average 1·3 t ha^{-1} extra grain; the effect of superphosphate is only slightly greater (1·4 t ha^{-1}). On land given P each year since 1852 the mean effect of silicate was 0·4 t ha^{-1}, or about 10%. Silicate gave greater increases where 96 or 144 kg N ha^{-1} were applied, and without applied N its effect was small (Table 3).

Since 1968 the rotation potatoes, beans, barley has been followed, in one phase only, on parts of the comparable plots with and without silicate, the remaining parts having barley grown continuously; Table 4 compares effects of silicate in barley on the four seasons available.

TABLE 4

Hoos Barley, effects of silicate of soda on barley grown continuously (C) and in rotation (R), grain at 85% dry matter, t ha^{-1}; means of 1970, 1973, 1976 and 1979

Treatment since 1852*		N, kg ha^{-1}, annually: 0 C	0 R	48 C	48 R	96 C	96 R	144 C	144 R	Mean C	Mean R
None	0	1·04	2·22	1·36	3·27	1·60	3·56	1·50	3·30	1·38	3·09
	Si	1·57	3·04	2·82	3·91	3·51	4·10	3·55	4·29	2·86	3·84
	Increase	+0·53	+0·82	+1·46	+0·64	+1·91	+0·54	+2·05	+0·99	+1·48	+0·75
P	0	1·69	3·13	3·14	4·55	3·67	5·05	3·64	4·86	3·04	4·40
	Si	1·74	3·47	3·66	4·83	4·28	5·09	4·42	4·98	3·52	4·59
	Increase	+0·05	+0·34	+0·52	+0·28	+0·61	+0·04	+0·78	+0·12	+0·48	+0·19
KMg(Na)	0	1·20	2·62	2·04	3·63	2·33	3·84	2·49	4·10	2·02	3·55
	Si	1·56	2·95	2·84	4·13	3·88	4·67	4·56	4·78	3·21	4·13
	Increase	+0·36	+0·33	+0·80	+0·50	+1·55	+0·83	+2·07	+0·68	+1·19	+0·58
PKMg(Na)	0	1·28	2·93	3·58	4·69	4·46	5·24	4·63	5·45	3·49	4·58
	Si	1·71	3·38	3·79	4·83	4·82	5·22	4·85	5·47	3·79	4·72
	Increase	+0·43	+0·45	+0·21	+0·14	+0·36	−0·02	+0·22	+0·02	+0·30	+0·14
Mean	0	1·30	2·72	2·53	4·04	3·02	4·42	3·06	4·43	2·48	3·90
	Si	1·64	3·21	3·28	4·42	4·12	4·77	4·34	4·88	3·34	4·32
	Increase	+0·34	+0·49	+0·75	+0·38	+1·10	+0·35	+1·28	+0·45	+0·86	+0·42

* Si: silicate since 1862

Symbols:
- Si Sodium silicate at 448 kg ha^{-1} annually (sodium silicate at 224 and calcium silicate at 224 kg ha^{-1} 1862–67)
- P Superphosphate at 35 kg P ha^{-1} annually
- K Potassium sulphate at 90 kg K ha^{-1} annually
- Mg Kieserite at 35 kg Mg ha^{-1} every third year
- (Na) Sodium sulphate at 15 kg Na ha^{-1} annually until 1973, none since

Except where no N was applied, silicate gave larger increases in continuous barley than in barley in rotation. In continuous barley the effect of silicate increased markedly with increased N; the residual N left by beans may therefore explain the appreciable increase for silicate in barley after beans without fertiliser N. But the effect of silicate did not increase with N applied to barley after beans. In continuous barley silicate gave increases nearly equal to those given by P; in barley after beans increases for silicate were less than those for P. Silicate gave negligible increases in barley after beans with P and 96 or 144 kg N ha^{-1} (where yields were about 5 t ha^{-1}) but in the corresponding continuous barley, with yields about 4 t ha^{-1}, silicate gave 0·7 t ha^{-1} without KMg(Na), 0·3 t ha^{-1} with KMg(Na).

Effects of silicate on beans and potatoes were small, except for the anomalous increase of 4·3 t ha^{-1} of potatoes with KMg(Na) (Table 5).

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TABLE 5

Hoos Barley: effects of silicate on potatoes (total tubers) and beans (grain at 85% dry matter), t ha⁻¹

		Potatoes*		Beans†	
		0	Si	0	Si
Treatment since 1852	None	6·91	7·37	1·1	1·3
	P	8·35	7·97	0·9	0·7
	KMg(Na)	20·10	24·39	2·0	2·2
	PKMg(Na)	39·20	38·77	2·4	2·5
	Mean	18·64	19·62	1·6	1·7

* 4 seasons, 1968, 1971, 1974, 1977
† 4 seasons, 1969, 1972, 1975, 1978
Symbols: Si Sodium silicate at 448 kg ha^{-1} annually (sodium silicate at 224 and calcium silicate at 224 kg ha^{-1} 1862–67
P Superphosphate at 35 kg P ha^{-1} annually
K Potassium sulphate at 90 kg K ha^{-1} annually
Mg Kieserite at 35 kg Mg ha^{-1} every third year
(Na) Sodium sulphate at 15 kg Na ha^{-1} annually until 1973, none since

Nitrogen fertiliser for forage maize

In experiments at Woburn and Rothamsted there has been a useful response by both grain and forage maize to nitrogen fertiliser at rates greater than those normally recommended (*Rothamsted Report for 1975*, Part 1, 148–149). The response curves have been anomalous; increasing the application from 50 kg N ha^{-1} to 100 kg often gave little or no increase, but 150 kg N frequently gave a substantial increase. Examples of these anomalies from three experiments are given in Table 6.

TABLE 6

Mean yields of forage maize (dry matter) and grain (at 85% dry matter), t ha⁻¹

			N (kg ha^{-1})		
(i)			50	100	150
	Without dazomet for grain maize	1973	5·3	4·6	5·7
	Without dazomet for forage	1977	7·8	7·6	8·6
	With dazomet for forage	1976	9·6	9·1	9·6
		1979	11·5	11·8	14·7
(ii)	Grain	1975	3·9	3·8	4·3
	Forage	1975	6·8	6·8	8·4
			N (kg ha^{-1})		
(iii)			40	80	120
	Forage	1976	8·8	8·8	9·0
	Forage	1977	8·0	7·8	9·1

(i) Grain and forage maize, Woburn
(ii) Control of pathogens experiment, Rothamsted
(iii) Nitrification inhibitors experiment, Rothamsted

On average of all our tests the successive increases in forage were +0·6 t ha^{-1} (100 kg N ha^{-1} minus 50 kg), +0·8 (150 kg N ha^{-1} minus 100 kg).

Split applications at sowing and 5 weeks later gave no more than similar amounts given all at sowing.

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Because of these results a series of annual experiments was started in 1979 to study the response curve of forage maize to a longer range of nitrogen fertiliser dressings.

The experiments tested all combinations of:

(i) Nitrogen applied 4 weeks before sowing

0, 60, 120, 180 kg N ha^{-1}

(ii) Nitrogen applied in the seed bed

0, 30, 60, 90, 120, 150, 180, 210 kg N ha^{-1}

Nitrogen applied early gave an increase in the mean yield from 8·9 t ha^{-1} with no nitrogen to 10·2 t ha^{-1} with 180 kg N ha^{-1}. Nitrogen applied to the seedbed gave the same anomaly as shown in the examples; with no nitrogen the yield was 9·0 t ha^{-1} but with 30 kg N ha^{-1} the yield was only 8·4 t ha^{-1}. However, further increases in the rate of N improved the yield successively by 0·9, 0·6, 0·1 t ha^{-1} until a plateau was reached with 120 kg ha^{-1}. (Barnard)

Fenugreek (*Trigonella foenum-graecum*). A small experiment tested combinations of:

(1) Inoculum: None, *Rhizobium meliloti* strain 2012.
(2) Nitrogen (as 'Nitro-Chalk'): None, 150 kg N ha^{-1} to seedbed, 150 kg N ha^{-1} at flowering.

The crop (var. Margaret) was sown in early May, flowered in late June and was harvested in October. Without fertiliser N inoculum increased the mean yield of grain from 0·7 t to 1·9 t ha^{-1}. Seedbed nitrogen without inoculation gave 2·6 t but with inoculation only 2·1 t ha^{-1}. Nitrogen at flowering was much less effective on uninoculated plots (1·1 t) than on inoculated plots (2·6 t). (Yeoman)

Staff

D. P. Yeoman was awarded the B.Sc. degree of the Council for National Academic Awards.

S. J. Parker joined the Section; his main responsibility is work with visitors to the Station. D. S. Martin-Smith joined the Small-plots Staff.

Publications

General Papers

1 McEwen, J. (1978) Practical field experimental aspects and experiences in the conduct of a multidisciplinary experiment on spring-sown field beans (*Vicia faba* L.). In: *Maximising yields of crops. Proceedings of a symposium organised jointly by the Agricultural Development and Advisory Service and the Agricultural Research Council. Harrogate, 17–19 January 1978.* HMSO, pp. 164–166.

2 McEwen, J. (1979) Field beans. Insecticides and fungicides. *BCPC Review of Insecticide and Fungicide Usage on Field Crops other than Cereals, 1978.* HMSO, 37–39.

Research Papers

3 Dyke, G. V. (1980) Covariance and field experiments. *Bulletin in Applied Statistics* **7**, 10–21.

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5 MCEWEN, J. & JOHNSTON, A. E. (1979) The effects of subsoiling and deep incorporation of P and K fertilizers on the yield and nutrient uptake of barley, potatoes, wheat and sugar beet grown in rotation. *Journal of Agricultural Science, Cambridge* **92,** 695–702.

6 MCEWEN, J., COCKBAIN, A. J., FLETCHER, K. E., SALT, G. A., WALL, C., WHITEHEAD, A. G. & YEOMAN, D. P. (1979) The effects of aldicarb, triazophos and benomyl plus zineb on the incidence of pests and pathogens and on the yields and nitrogen uptakes of leafless peas (*Pisum sativum* L.). *Journal of Agricultural Science, Cambridge* **93,** 687–692.

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