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ROTHAMSTED  
RESEARCH

## Report for 1974 - Part 1

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### Field Experiments Section

**G. V. Dyke**

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## FIELD EXPERIMENTS SECTION

G. V. DYKE

### Staff

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### Field Plots Committee

The field experiments at Rothamsted, Woburn and Saxmundham are controlled by the Field Plots Committee: G. W. Cooke (Chairman), G. V. Dyke (Secretary), J. McEwen (Deputy Secretary), L. Fowden, I. J. Graham-Bryce, J. M. Hirst, A. E. Johnston, F. G. W. Jones, J. R. Moffatt, R. Moffitt, J. A. Nelder and C. P. Whittingham. J. P. Dickinson, who joined the Farm staff during the year, also attended the meetings.

**TABLE 1**  
*Number of plots in 1974*

	Grain	Roots	Hay	Total
<b>Full scale plots (yields taken):</b>				
<i>Classical experiments:</i>				
Rothamsted	320	67	208	595
Saxmundham	—	—	80	80
<i>Long-period rotation experiments:</i>				
Rothamsted	612	116	104	832
Woburn	338	284	88	710
<i>Crop-sequence experiments:</i>				
Rothamsted	540	172	262	974
Woburn	352	478	—	830
Saxmundham	136	—	—	136
<i>Annual experiments:</i>				
Rothamsted	1090	446	120	1656
Woburn	254	227	—	481
Saxmundham	54	—	—	54
<i>Totals:</i>				
Rothamsted	2562	801	694	4057
Woburn	944	989	88	2021
Saxmundham	190	—	80	270
<b>Total</b>	<b>3696</b>	<b>1790</b>	<b>862</b>	<b>6348</b>
<b>Full-scale plots (no yields taken):</b>				
Rothamsted				789
Woburn				256
<b>Microplots:</b>				
Rothamsted				1686
Woburn				462
Saxmundham				226
<b>All plots total</b>				<b>9767</b>

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J. R. Moffatt retired on 31 December 1974 after 41 years of service on the Committee and its Sub-Committees and Working Parties. As well as taking responsibility for the execution of most of the field work on experiments at Rothamsted and Woburn he contributed much to the Committee's discussions.

Table 1 shows the number of plots on the three farms; the total is slightly less than in 1973. Again the number of plots of grass increased, mainly in annual experiments. Plots in root crops (mainly potatoes) decreased by about 150 at Rothamsted but increased slightly at Woburn.

### Field Experiments Section

Members of the Section, working from Committee decisions, produce randomisations, plans and tables of quantities needed for the field experiments. When proposals for experiments are submitted they are discussed (mainly with McEwen) and at this stage it is often possible to initiate collaboration between members of departments who are working on similar or related subjects.

The Section also continued its work of scientific liaison; we arranged 200 separate programmes for visitors (individuals or groups). The visitors in 1974 included 17 groups from overseas and totalled about 3000 (as usual). In addition about 160 came to the Subject Day on Beans and 4000 to the Open Days in July.

We are beginning a modest scheme of visual aids: Pattison (with help from members of Plant Pathology and Nematology Departments) made a video tape recording of the scanning and transmission electron microscopes and Quantimet. He has begun a series of short ciné films on aspects of Rothamsted's work; ICI gave us a copy of their film 'Ammonia', part of which was made at Rothamsted.

### Small-plot experiments

The Small Plots staff undertook all operations on 43 experiments, and some operations, many of which were very time-consuming, on 25 others. These experiments involved 1088 plots on land managed by the Small Plots staff and 514 on Farm land. As in 1973 our resources were strained to the utmost, but little scientific work suffered for that reason. However, if the upward trend in the volume and complexity of its work continues, as seems likely, extra staff will be needed to accommodate it, even if future seasons are less difficult than 1974.

The facilities on Small Plots land on Long Hoos were improved late this year by the provision of mains electricity outlets, available to all experimental sites, for recording instruments, spore and insect traps, etc.

The Claas 'Compact 20' combine harvester was further modified during last winter to improve the sweeping of the cutting table and other input mechanisms. We believe that its performance has been improved. A larger hopper was constructed to enable it to be used as a stationary thresher for cereals and field beans (*Vicia faba*). Direct combine-harvesting of beans is usually unsatisfactory because of losses of grain by shattering at the cutter bar. The best method we have found for harvesting beans on small plots is to cut by hand and thresh in the combine via the hopper. (Wilson)

### Conference on field methods

In February a two-day conference was held at Rothamsted on 'Methods of Field Experimentation with Arable Crops'. It was attended by 60 representatives of ADAS, universities, ARC institutions and commercial organisations, as well as many members of Rothamsted staff.

Then and subsequently there was substantial support for the establishment of a field

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experiments equipment bureau at Rothamsted as a means of communication between research centres and individuals on matters of mechanisation and techniques in field experimentation. A start has been made in setting up this organisation and information may be obtained from and lodged with Wilson.

### Soil fumigation and nitrogen for spring beans (*Vicia faba* L.) at Woburn

Since 1969 spring beans have been grown on the same site each year on an experiment testing all combinations of:

- (i) No fumigant, dazomet at 450 kg/ha (in autumn),
- (ii) No nitrogen, 125, 250 kg N/ha as 'Nitro-Chalk'.

The site chosen had not grown beans for many years but was known to be infested with migratory nematodes of the genera *Trichodorus*, *Pratylenchus* and *Tylenchorhynchus*. The treatments, applied cumulatively each year, had very consistent effects on yield.

TABLE 2  
Spring beans: dazomet and nitrogen experiment

Treatment (kg/ha)		Year						Mean
dazomet	Nitrogen	1969	1970	1971	1972	1973	1974	
0	0	1.7	1.2	1.8	0.7	2.6	2.3	1.7
	125	1.3	1.2	1.3	0.3	2.3	1.7	1.4
	250	1.0	0.7	1.2	0.3	2.8	1.7	1.3
450	0	2.0	1.2	2.4	1.5	2.9	1.9	2.0
	125	2.0	1.5	2.6	1.8	3.4	2.7	2.3
	250	2.3	1.6	2.8	1.9	3.3	3.0	2.5

(±0.14) (±0.05) (±0.24) (±0.21) (±0.21) (±0.19) (±0.11)\*

Note: Standard errors for each year based on variation between replicates (10 degrees of freedom)

\* Based on annual variation of treatment effects (25 D.F.)

Dazomet applied alone increased yield slightly. Applied nitrogen decreased yield on unfumigated soil but increased yield where dazomet was applied.

Nitrogen had little effect on numbers of migratory nematodes but dazomet had large effects. Table 3 shows the mean effects (averaged over years and nitrogen treatments). Numbers of both *Trichodorus* and *Tylenchorhynchus* were greatly lessened in the spring following autumn fumigation but both genera increased rapidly during the growing season.

Stem eelworm (*Ditylenchus dipsaci*) was not present until 1973 when a small infestation was accidentally introduced in the seed. Although the subsequent soil infestation was

TABLE 3  
Spring beans: dazomet and nitrogen experiment  
Numbers of migratory nematodes/litre of soil

Treatment dazomet (kg/ha)	Genus					
	<i>Trichodorus</i>		<i>Pratylenchus</i>		<i>Tylenchorhynchus</i>	
	Spring	Autumn*	Spring	Autumn*	Spring	Autumn*
0	300	450	185	140	1800	2700
450	45	220	0	10	70	800

\* Before applying dazomet

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partially controlled by dazomet, numbers increased greatly in 1974 (to 8000/litre of soil on unfumigated plots, 1400 on fumigated) and the experiment was terminated after harvest.

Fungal diseases on roots did not differ sufficiently to account for the consistent yield differences and plants maintained a thick growth of lateral roots throughout the season. Superficial discoloration of root cortex, ranging from red-brown to grey-black, was common. Scores for root discoloration in July were similar with or without dazomet except in 1974 when the means were 15 and 63% respectively. Fungi were isolated more frequently from discoloured than from white roots and species of *Cylindrocarpon*, *Pythium*, *Rhizoctonia* and *Fusarium* were the most prevalent.

Nodulation by *Rhizobium* was lessened by both dazomet and nitrogen but even plots given both had about half the nodular material present on untreated plots.

Despite the very consistent effects of the treatments on yield there is no convincing explanation for the effects of dazomet on the nitrogen response. (McEwen, with Hornby and Salt, Plant Pathology Department and Mrs. Janet Fraser, Nematology Department)

### The effects of incorporating P and K into the subsoil

A small pilot experiment was started on the light soil at Woburn to test the effect of applying P and K fertiliser to the subsoil at rates calculated to make the subsoil as rich in available P and K as the topsoil. Superphosphate and muriate of potash, at 1930 kg P<sub>2</sub>O<sub>5</sub>/ha and 460 kg K<sub>2</sub>O/ha, were dug into the subsoil by hand, the topsoil being temporarily removed. Other treatments were:

- (i) the same amounts of P and K incorporated into the topsoil without disturbing the subsoil
- (ii) subsoil dug without additional PK
- (iii) subsoil undisturbed, no additional PK.

The usual amounts of N, P and K used in farming practice were applied to all the crops in addition to P and K on test:

	N	(kg/ha) P <sub>2</sub> O <sub>5</sub>	K <sub>2</sub> O
Wheat	100	60	60
Barley	90	70	70
Sugar beet	180	105	210
Potatoes	250	250	390

**TABLE 4**  
*Deep PK experiment*

		Mean yields, t/ha				S.E.
		None	Subsoiling alone	P and K to topsoil	P and K to subsoil	
Wheat	Grain	5.6	6.5	5.2	5.9	(±0.61)
	Straw	9.0	10.8	10.9	11.0	(±0.63)
Barley	Grain	4.9	5.2	4.5	6.2	(±0.76)
	Straw	4.9	5.4	4.9	5.3	(±0.49)
Potatoes, total tubers		68.8	65.1	72.1	78.5	(±0.97)
Sugar-beet	Sugar	4.9	5.0	5.1	5.5	(±0.20)
	Tops	29.2	32.6	27.1	39.0	(±2.93)

Standard errors based on 6 degrees of freedom

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The cereals were damaged by birds shortly before harvest and differences in yield were not significant (Table 4). Both potato and sugar beet crops had enhanced yields from PK incorporated into the subsoil. (McEwen)

### Designs for field experiments involving interference

The problems of field experimentation on the control of locally-dispersed pathogens in which 'interference' between adjacent plots may affect yields have led to experiments of systematic design (see p. 221) and to a consideration of 'serially-balanced' designs (Finney & Outhwaite, *Proceedings of the Royal Society B* (1956), **145**, 493-507). A computer program has been written to produce designs for four treatments with the following properties.

- (i) Each has 38 plots in one line, comprising nine replicates of four treatments A, B, C and D plus a dummy plot at each end.
- (ii) Every possible sequence of three treatments (but excluding repeated treatments), e.g. ABA and ABC but not AAB, occurs once and only once in the sequence.

These designs (more than 1500 in number) allow the effects of left-hand and right-hand neighbours of each treatment to be separately estimated. We hope that (with members of the Plant Pathology Department) one such design will be tried in the field in 1975. (Dyke, with Christine Shelley, Computer Department)

### The milling and baking quality of Rothamsted and Woburn wheat

Since 1968 we have provided many samples of wheat grown on experiments at Rothamsted and Woburn to the Flour Milling and Baking Research Association at Chorleywood. Some experiments have been modified at their request. A variety of tests (Elton & Greer, *ADAS Quarterly Review* (1971), No. 2, 85-94) was applied to each sample (including the assessment of the quality of a sample loaf baked with flour ground in a standard mill).

The best known way for a farmer to grow wheat of good milling quality is to select a variety bred for quality rather than yield. Maris Widgeon (MW) is one such variety and it was included in most of our variety trials; Cappelle (CA) which has been our standard variety for some years was also included. In the following paragraphs we omit effects that were small in relation to the differences between these two varieties.

**Bushel weight.** (MW 60.3 lb, CA 59.4; corresponding specific weights are 75.2, 74.2 kg/hl). 1971 (when the summer was dull and wet and leaf diseases were prevalent) gave bushel weights about 1 lb (1.1 kg/hl) less than 1969, 1970 and 1972. Wheat grown after two or more years' wheat or barley at Rothamsted had a smaller bushel weight than wheat after a two-year break but the effect varied greatly between experiments. Increased applications of fertiliser N gave increases of 2 lb (2.2 kg/hl) or more in some experiments but not in all.

**Yield of flour (as % of grain).** (MW 75.0, CA 72.5). 1969 (a hot, dry summer in which loose smut was prevalent) gave the least yield of flour, 1972 (cool and dull) the most; the difference was about 3%.

Wheat grown after leys of various types gave 4-5% more flour than wheat after an arable sequence chosen to minimise soil-borne diseases (especially take-all). Nitrogen had only small effects on yield of flour.

**Colour of flour** (smaller numbers denote better colour; the grade of most bread flour in Britain is about 3 units) (MW 2.6, CA 3.0). 1971 (mean 3.6) was much the worst season, 1972 (mean 2.1) the best.

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Increased fertiliser nitrogen (and, on Broadbalk, farmyard manure) worsened the colour of the flour by, at most, 0.6 units. Effects of crop sequences were irregular.

**Percentage protein in flour (at 14% moisture).** (MW 10.9, CA 9.8). Wheat grown after a two-year break at Woburn had 0.7% more protein than comparable Rothamsted wheat; wheat following wheat or barley at Rothamsted had 0.2% less protein than wheat after the break. Fertiliser N consistently increased the protein content of the flour even at the greatest rates tested (252 kg); average increases for N applied in spring ranged from about 1% to nearly 3%.

Averaging four varieties grown in 11 experiments, a split dressing (125 kg N/ha in spring plus 63 kg at flowering) gave 0.4% more protein than 188 kg all in spring, 1.0% more than 125 kg in spring with no late dressing.

The results of baking tests have not yet been fully examined.

### Staff

C. R. L. Scowen retired at the end of March; his patience and kindness in explaining the work of the station will be remembered by a multitude of visitors.

M. B. Masia (Lesotho), A. O. Obi (Nigeria), A. Were (Kenya) spent different lengths of time in the Section.

Dyke attended a joint Science Research Council/ARC Management Course organised by the SRC.

### Publication

#### RESEARCH PAPER

- 1 DYKE, G. V. (1974) Designs to minimize loss of information in polynomial regression. *Applied Statistics* **23**, 295–299.