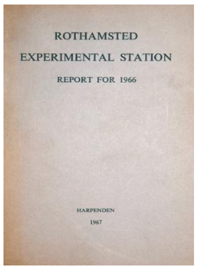
ROTHAMSTED RESEARCH

Rothamsted Report for 1966

Full Table of Content


ROTHAMSTED
EXPERIMENTAL STATION
REPORT FOR 1966

HARPENDEN
1967

The Saxmundham Experiments

G. W. Cooke

G. W. Cooke (1967) *The Saxmundham Experiments ;* Rothamsted Report For 1966, pp 248 - 254 - **DOI: https://doi.org/10.23637/ERADOC-1-14**

The Saxmundham Experiments

BY G. W. COOKE

Weather and cultivations. Instruments to record air and soil temperatures, wind, humidity and radiation were installed to supplement the rainfall measurements that have been made at Saxmundham for 40 years. No local station records anything other than rainfall, so there are no long-term averages to compare with our measurements. (In 1966 air and soil temperatures at Saxmundham followed the same pattern as at Rothamsted, but were slightly warmer during summer. The rainfall patterns were similar, though monthly variations were larger at Saxmundham, which also had more wind than Rothamsted.) Rainfall was near to average for the first 6 months (Table 1), and after dry weather in March cereals and

TABLE 1

Temperature and rainfall at Saxmundham

	Mean temperature (° F)	Rainfall in 1966		Average rainfall (in.)		Average rainy days	
		Total (in.)	Rainy days*	1930–66	1960–66	1930–66	1960–66
January	36·6	2·30	15	2·22	2·02	6·7	11·6
February	41·3	2·06	15	1·63	1·19	5·3	8·9
March	41·6	0·71	11	1·49	1·73	5·2	10·0
April	45·2	2·07	16	1·68	2·03	5·8	12·1
May	52·9	1·64	13	1·66	1·51	5·4	9·7
June	58·8	2·56	10	1·78	1·84	5·4	8·1
July	56·0	3·32	8	2·24	2·59	6·0	9·6
August	57·3	3·20	12	2·40	2·53	6·5	11·0
September	54·6	0·51	5	2·20	2·15	5·5	7·7
October	51·7	4·31	19	2·55	2·92	6·6	10·6
November	41·0	3·39	20	2·70	2·58	8·0	14·7
December	39·8	3·15	24	2·11	2·35	6·9	13·0
Year	48·1	29·22	168	24·7	25·4	73·3	127·0

* From June 1966 observations were not made separately on Sundays.

beans were sown, and potatoes planted, in good conditions. During the second 6 months about 18 in. of rain fell, and October to December were very wet; rain falling on 63 days in these 3 months delayed sugar-beet harvesting and ploughing, and may lessen yields of the 1967 crops (Trist & Boyd, *J. agric. Sci. Camb.* (1966), **66**, 327–336). Only two of the last ten years (1957–58 and 1960–61) were wetter. (R. J. B. Williams)

The improvement in ease of working the soil, and the way it accepts water and drains, caused by mole draining in 1964, and by ploughing the whole field deeper, was maintained. There was very little run-off and none that moved soil from one plot to another.

Rotation I Experiment. The manuring used since 1899 was changed to that described in *Rothamsted Report* for 1965 (pp. 236–237). None of the crops yielded well (Table 2). Cappelle wheat sown after fallowing the legume break in 1965 was severely attacked by wheat-bulb fly; it recovered surprisingly well, but the plant was too thin for a good yield. Spring beans were sown under good conditions, but were badly damaged by birds, and

https://doi.org/10.23637/ERADOC-1-14

TABLE 2

Yields of cereals, beans and sugar beet in Rotation I Experiment at Saxmundham in 1966

Annual treatment* to		Wheat grain (cwt)		Barley grain (cwt)		Beans grain (cwt)	Old treatments to sugar beet, roots tons/acre		New treatments to 1966 sugar beet		
1965	1966	1966	1956–65	1966	1956–65	1966	1956–65 average	1966 yield	Roots tons/acre	Sugar cwt/acre 1966	Tops tons/acre 1966
None	1N, 2P	17·8	10·4	28·1	5·3	8·8	2·3	3·5	9·3	32·1	3·8
n	2N, 2P	27·1	18·6	29·8	10·9	9·1	3·0	4·4	13·7	47·5	6·9
p	1N, 1P	19·8	13·6	25·4	7·2	8·4	6·2	5·0	9·6	33·0	3·9
k	1N, 2P, K	16·7	9·9	19·5	4·8	7·5	2·8	2·1	7·3	25·0	3·9
np	2N, 1P	28·9	24·0	31·6	16·7	14·3	9·6	12·7	11·3	39·8	7·4
nk	2N, 2P, K	28·3	19·0	32·4	11·2	15·2	2·4	3·7	10·1	35·2	6·4
pk	1N, 1P, K	20·9	13·5	28·0	7·3	16·8	6·0	7·3	10·4	36·7	4·2
npk	2N, 1P, K	32·2	23·3	29·1	18·6	15·1	10·0	11·2	10·1	35·7	6·0
Bone meal	Bone meal†	9·9	14·3	11·2	8·2	7·3	7·2	5·4	4·7	15·0	2·8
FYM‡	FYM‡	18·7	22·6	34·2	18·6	24·3	13·1	11·1	13·5	44·6	5·8

* Fertiliser rates in cwt/acre are:

n = 0·31 N 1N = 0·5 and 2N = 1·0 for cereals and sugar beet, 0 and 0·5 cwt N for beans.
p = 0·4 P_2O_5 1P = 0·4 and 2P = 0·8 P_2O_5 } for all crops.
k = 0·6 K_2O_5 K = 1·0 K_2O }

† Bone meal at 4 cwt/acre each year.

‡ 6 tons of FYM until 1965, 12 tons/acre for 1966 crops.

over most of the block there were too few plants. The FYM-treated plot (where beans were sown a little deeper and grew quicker) had most plants and yielded best.

The sugar beet was disappointing. On plots given phosphate for the first time since 1899 the crop grew slowly and irregularly; rapid and even growth on such poor soil would have needed much more than the 0·8 cwt P_2O_5/acre applied broadcast to the seed-bed (placing this dressing beside the seed might have been better). But even on plots with good reserves from the old annual dressings, and a fresh dressing of 0·4 cwt P_2O_5/acre, the crop was backward and the leaves were pale-green from July to harvest. On some plots the plants were very uneven, and were small in some lengths of row but large in other lengths or in adjacent rows. The tap-roots of small plants were stunted, with a beard of fibrous lateral roots resembling some forms of Docking disorder, but there were only few plant-parasitic nematodes around their roots. Mycelium of *Rhizoctonia solani* was common on the dead and moribund roots, and numerous other weakly parasitic fungi grew from them on agar plates. On all plots growth was probably restricted during wet periods by waterlogging and lack of aeration; the soil became rather compact by preparing the seed-bed and sowing the beet when the deeper soil was wet.

Proctor barley, sown in very good conditions in March, was not damaged by birds or by any obvious pathogen, and did not lodge. Why it yielded only 34 cwt/acre on the best plots is not known.

The old (1899–1965) treatments were maintained on small areas of all crops except wheat; these sub-plots were discarded when harvesting barley and beans, but the beet were weighed and yields are included in Table 2 (they varied in the same way as average yields for these treatments over the last 10 years).

Of the main plots only that receiving bone meal is unchanged, to show differences between 1966 crops and previous averages; wheat and sugar beet yielded less than the average of 1956–65, and barley more.

https://doi.org/10.23637/ERADOC-1-14

Two amounts of nitrogen, phosphorus and potassium were tested. The nitrogen test was a simple one of 1·0 *v.* 0·5 cwt N/acre for all crops except beans; the phosphate test was of 0·8 *v.* 0·4 P_2O_5/acre and was complicated because the smaller amount was applied to plots with residues of 0·3–0·4 cwt P_2O_5/acre applied annually for 65 years. Results of the tests are summarised in Table 3 (omitting the beans that were damaged by birds) and using for comparisons only plots supplied with P for the N test, with N for the P test and with NP for the K test.

TABLE 3

Yields from N, P and K fertilisers at Saxmundham in 1966 compared with average yields in 1956–65

Fertiliser rate cwt/acre		Wheat (cwt)		Barley (cwt)		Sugar beet (tons)	
		Grain	Straw	Grain	Straw	Roots	Tops
		Test of nitrogen					
N	*1966*						
0·5		18·8	12·1	25·2	15·9	9·2	4·0
1·0		29·1	20·0	30·7	18·8	11·2	6·7
	1956–65						
0·0		13·6	—	7·2	—	6·1	—
0·31		23·6	—	17·6	—	9·8	—
		Test of phosphate					
P_2O_5	*1966*						
0·4		25·4	17·6	28·5	18·0	10·3	5·4
0·8		22·5	14·4	27·4	16·6	10·1	5·2
	1956–65						
0·0		18·8	—	11·0	—	2·7	—
0·4		23·6	—	17·6	—	9·8	—
		Test of potassium					
K_2O	*1966*						
0·0		23·4	14·1	28·7	16·4	11·0	5·5
1·0		24·5	17·9	27·2	18·3	9·5	5·2
	1956–65						
0·0		24·0	—	16·7	—	9·6	—
0·6		23·3	—	18·6	—	10·0	—

The response of the wheat suggests that more than 1·0 cwt N/acre would have been beneficial, but for barley and sugar beet 1 cwt N/acre must have been near the optimum. Using 0·4 cwt P_2O_5/acre on the old phosphate-treated plots gave larger yields of all crops than twice as much applied where P has not been used before. This was not unexpected; the surprising result is how closely yields with this first dressing approach those from the richer soil. Potassium fertiliser tended to diminish yields, reversing the trend shown by the 1956–65 averages, where K increased barley and sugar beet slightly. Much of this apparent difference was caused by uniformly poor yields from the plot given muriate of potash alone in the old scheme; it is in the middle of each block where, as Trist and Boyd comment, the soil is shallower. Nevertheless, the old NP and NPK treated plots are side-by-side, and in 1966 giving K to this pair diminished sugar-beet and barley yields.

The old 6 tons/acre dressing of FYM was doubled for the 1966 crops. The FYM plot had to be ploughed separately to work the dressing into the fallow for wheat, which yielded much less than previous averages both with FYM and with NPK. The extra FYM gave larger-than-average yields of barley, but not of beet.

https://doi.org/10.23637/ERADOC-1-14

Rotation II Experiment. Modifications to this experiment were described last year (*Rothamsted Report* for 1965, p. 237). The fresh dressings of FYM and triple superphosphate shown in Table 4 were applied for the potatoes grown in 1966.

In autumn 1965 20 tons/acre of FYM were applied to the barley stubble on plots 4 and 5, together with half of the fresh phosphate for plots 5, 6 and 7. The remainder of the annual phosphate dressings was applied over the plough furrows in March. Seed-beds of all plots had 1·2 cwt N/acre and 2·0 cwt K_2O/acre before planting Pentland Dell potatoes on 31 March. Leaves were sampled on 15 June and tubers lifted on 20 September 1966. Table 4 gives mean yields of fresh tubers and of dry matter and also the ratios of the dry weight of leaf samples from each plot taking values from plot 1 (no phosphate since 1899) as standard.

TABLE 4

Yields of potatoes in Rotation II Experiment at Saxmundham

Plot No.	Treatment per acre: 1899–1964 per 4 years	cwt P_2O_5 applied in 1966	FYM in 1966 (tons)	Ratio of dry weight of leaves in June (relative to treatment 1)	Yields tons/acre: Total tubers	Dry matter
1	None	None	—	1·00	7·45	2·02
2	10 tons FYM	None	—	1·50	14·56	4·11
3	10 tons FYM + 5 cwt super (to 1920) 7½ cwt since	None	—	1·94	16·85	4·74
4		None	20	2·51	20·47	5·42
5		1·50	20	2·50	20·34	5·55
6		1·50	—	2·60	18·23	4·98
7		3·00	—	2·32	18·60	5·16
8	10 tons FYM plus 10 cwt super till 1952	None	—	2·32	16·28	4·61

The largest yields, over 20 tons/acre, were from plots given superphosphate and FYM from 1899 to 1964 and a further dressing of FYM in 1965. About 2 tons/acre less came from plots with fresh superphosphate but without FYM. Residues from dressings (once every 4 years since 1899) of FYM with superphosphate (plot 3), or without (plot 2), more than doubled yields (as with barley in 1965). The weight of leaf samples in June assessed the relative values of residues and fresh dressings reliably.

Yields alone cannot show whether the larger crops on plots given fresh FYM were from its physical effects or from the extra nutrients it provided. Crop and soil analyses now being done will help to decide. The residues from the old dressings of phosphate were too little to give maximum yield, and the increases from fresh dressings on Plots 6 and 7 stress the need to use much phosphate for potatoes on such soils. (G. E. G. Mattingly)

Intensive wheat growing experiment. An experiment began in autumn 1965 to measure the prevalence of soil-borne diseases, and to compare the yields of continuous winter wheat with wheat grown in rotation with crops other than cereals. It is superimposed on plots of Rotation II Experiment that were abandoned in 1952; the whole area received 1·0 cwt P_2O_5 and 1·0 cwt K_2O/acre to lessen any differential residual effects of the fertiliser treatments applied before 1952.

https://doi.org/10.23637/ERADOC-1-14

Cappelle wheat, sown on 8 October, established well, but in the spring was severely infested by larvae of the dipterous shoot-boring insect *Opomyza florum*; many plants and primary tillers were killed. This damage was surprising, because in earlier experiments at Rothamsted in which *O. florum* was prevalent on early sown wheat the larvae killed only late-formed tillers (*Rothamsted Report* for 1957, p. 119). The wheat this year all followed barley, and take-all was prevalent and damaging on all plots, even those given 1·8 cwt N/acre. However, the incidence of disease, and the yields (shown in Table 5), differed on the two halves of the experiment which had been cropped differently before 1965. (D. B. Slope and Judith Etheridge)

TABLE 5

Effects of previous cropping and nitrogen fertiliser on infection with take-all and yields of winter wheat in 1966

	A			B		
Cropping 1962	Sugar beet			Spring oats		
1963	Spring barley			Winter wheat		
1964	Winter wheat			Spring beans		
1965	Spring barley			Spring barley		
Nitrogen applied, cwt/acre	0·6	1·2	1·8	0·6	1·2	1·8
% plants with take-all (22 June)	94	82	82	54	55	32
Grain yield (cwt/acre)	17·6	25·5	28·1	21·3	32·0	34·9
Nitrogen in grain, %	1·78	1·93	1·95	1·86	1·94	2·07
Nitrogen in grain, lb/acre	30	47	52	37	59	69

Nitrogen contents of the grain (Table 5) show how inefficiently wheat used the large amounts of fertiliser-N needed to produce tolerable yields from crops severely attacked by take-all. On section A, where take-all was worst, one-quarter of the first dose of N tested (1·2–0·6 cwt N/acre) was recovered in grain, on section B, with less take-all, a third was recovered. Of the second dressing tested (1·8–1·2 cwt N) 7½% was recovered in grain on Section A, and 15% on Section B; in spite of this very small recovery the extra nitrogen increased yield enough to pay its cost. (Nitrogen was also used inefficiently in Rotation I experiment. Of the dressing tested (1·0–0·5 cwt N) 30% was recovered in wheat grain, 20% in barley grain. The straw in the Intensive Wheat Experiment was not analysed; in Rotation I, allowing for the nitrogen in straw, the recoveries increased to only 37 and 23% for wheat and barley respectively.) (R. J. B. Williams)

Work on soils and subsoils. Attempts are being made to determine whether crop yields are diminished by the unstable structure of the surface soil, and by the impervious, badly drained, subsoil. An experiment that tests soil conditioners is described earlier in this Report (pp. 38–39).

The subsoil immediately below plough depth ranges from a blue impervious clay, devoid of stones and plant roots, to sandy loam with or without gravel. In the most gravelly subsoil (10–14 in. deep) sampled, stones larger than 2 mm formed 28% of the dry material. Most of the subsoil under Rotation I shows gleying, but a few small areas have deep and well-structured clays, or reddish-brown sands. Complete contrasts in subsoil texture occurring within a few yards do not cause differences in crop growth visible from the ground.

https://doi.org/10.23637/ERADOC-1-14

Bulk densities were measured of some subsoils under the block where barley grew in 1966. All subsoils were very compact, but they differed in porosity and in moisture content:

Plot no. and subsoil	Moisture %	Density (g/ml)	Total porosity (%)
26 (Gleyed clay)	23	1·60	37
25 (Oxidised sandy loam)	16	1·76	31
23 (Moderately gleyed clay)	17	1·77	30

(Bulk densities around 1·7 are usually considered to impede root growth.)

The soil does not hold much water in spite of its heavy texture. Uncropped soils sampled from February to November had from 14 to 20% of water in the surface and from 17 to 19% in the subsoil. Several of the samples were taken after much rain when the soil must have been at field capacity. The least amount found in soil under crops after dry weather in summer was 13%. It seems that the soil cannot hold more than 20% of total water, and the proportion of this available to crops must be less than in soil with better structure.

Settling and consolidation of the 9-in.-deep cultivated soil was measured in 1966 using a micro-survey apparatus similar to that of B. Wilton (*J. agric. Engng Res.* (1964), **9**, (3) 214). Duplicate measurements made on uncovered strips, and on strips of soil protected from rain by polythene shields, detected swelling and slaking of the soil surface when wet and shrinking in dry weather.

Covered soil shrank slightly and was affected a little by humidity; it reached equilibrium after 5 months, when the surface had fallen 0·6 in. Uncovered soil swelled a little at first, and the surface then slaked quickly during the first 2 months, even with less than 3 in. of rain. Heavier rain later in the year made the surface soil swell again and halved the effect of consolidation during the summer. The last 3 months of the experiment were very wet, but the soil reached equilibrium, and the surface was only 0·3 in. below the level when measurements started in April. We had expected that rain would consolidate the soil more, but slaking was confined to the surface. These results suggest that, if wet soil is not consolidated by implements, and the waterlogging that causes slaking below the surface is avoided, good structure caused by weather and correct cultivations can be preserved.

Rain water samples collected during the year were analysed. (The site is only about 6 miles from the sea, and we know little about the composition of rain near the east coast.) Potassium varied most (0·2–7·4 ppm), and calcium least in different collecting periods.

	In. of rain in periods	Nutrients in 1 in. of rain (lb/acre)			
		Na	K	Mg	Ca
March–October (8 collecting periods)	17	0·47	0·55	0·11	0·30
August–October (3 periods)	6	0·57	1·11	0·18	0·40

Annual rainfall may supply useful amounts of sodium and potassium and about as much magnesium as cereals remove. (On average 2·6 lb Mg/acre were removed by wheat and 3·8 lb/acre by barley grown in Rotation I Experiment in 1966.) Presumably all sodium not taken up by crops is

https://doi.org/10.23637/ERADOC-1-14

lost in drainage, but some potassium may be retained (calcium in rain is unimportant on this calcareous soil). Drainage waters collected at Saxmundham after much rain in December had the following compositions (in parts per million):

Drainage from	NO_3–N	P	K	Na	Ca	Mg
Grass field	0	0·12	1·8	13	122	8
Arable land (i)	8	0·01	0·5	17	175	9
Arable land (ii)	10	0·01	0·6	17	175	9

No nitrate was being lost from the adjacent grass field, but drainage from the arable land contained much. The drainage contained very little phosphorus, little potassium, but much sodium. Unless the soil contains sodium-containing minerals that are weathering quickly, the source must be largely rain-water. (R. J. B. Williams)

https://doi.org/10.23637/ERADOC-1-14