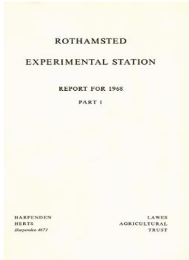
Report for 1968 - Part 1

Full Table of Content


ROTHAMSTED

EXPERIMENTAL STATION

REPORT FOR 1968

PART 1

Broom's Barn Experimental Station

R. Hull

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BROOM'S BARN EXPERIMENTAL STATION

R. HULL

Yellows and aphids in sugar beet

Favourable weather allowed more than half the national sugar-beet crop to be sown by the end of March and 90% by mid-April. Mean air temperature during the winter in eastern England was near average, except in February, when it was 3·1° F less. On past experience such weather gave an expectation that yellows would not be prevalent; less than 10% infection by the end of August. In spite of severe dust storms in March and frosts and snow in April, the crop grew rapidly and the foliage of many crops had met in the rows by early June. Green aphids increased slowly and similar populations were reached about one week later than in 1967. In mid-June the east of England was stormy while the centre and west had anticyclonic weather. This unusual weather produced an unusual pattern of aphid infestation. The mean infestation of green aphids late in June was 0·2 plant, but infestations were much larger in the centre and west than in the east of England. Spray warnings were given where the infestation seemed to justify them, but they were fewer than usual in the east, where most of the beet is grown. A total of 135 000 acres of beet was treated with insecticide against aphids. Some infested crops could not be sprayed because the foliage was already too dense or the weather was unfavourable. Crops in eastern England remained relatively free from yellows compared to those in central areas where yellows was prevalent during September. However, the disease developed late and the crop was so forward that yield losses were not large. At the end of August, mean incidence of yellows in the factory areas averaged 7·2%, but it ranged up to 15% and there were 20000 acres of beet, much in the Peterborough and Ely factory areas, with more than 20% of plants infected.

Control by aphicides. Six trials in eastern England and one on the south coast compared the incidence of yellowing viruses and of aphids in unsprayed plots and in those sprayed when a warning was sent to growers in the area. Pelleted Monotri seed was used, and for half of the plots menazon (4% by weight of the seed) was incorporated in the pellets. Aphids colonised the crops late and spray warnings were not issued in the areas of three of the trials; wet weather prevented spraying another of the crops. On average, there were only half as many green aphids on the menazon-treated plots in June, and in July two-thirds as many as on the untreated plots. Black aphids were few, except near Spalding where the menazon-treated plots had only a third as many as untreated plots. Menazon incorporated in the seed pellets decreased the number of seedlings from an average of 8·8 to 6·9/yd of row and the final plant population by an

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average of 5100/acre. It had no effect on yellows. Although plants grown from menazon-treated seed were on average larger, because fewer, than those from untreated seed, the treatment decreased yield of roots/acre. At only four of the sites were more than 20% of the untreated plants infected with yellows at the end of September, but on three of these spraying at the warning decreased yellows and significantly increased yield. One of the trials at Broom's Barn testing menazon in pelleted seed had a uniform stand of 36000 plants/acre but few plants got yellows and treatments did not affect yield.

A trial at Broom's Barn and 15 in different sugar-factory areas compared the germination of sugar beet seed of five varieties pelleted by the Germain process, with or without menazon incorporated in the pelleting material. On average 4% or 6% by weight of menazon decreased seedling emergence by 18·0% (from 11·3 to 9·3/50 in. length of row), but varieties were affected differently. At Broom's Barn, when sown in early April, 1968, Sharpe's E pelleted in October 1967 germinated less well than similar seed pelleted in February 1968. (Heathcote)

'Temik' (2-methyl-2-(methylthio)propionaldehyde *O*-(methyl-carbamoyl) oxime), as granules drilled in the furrow with the seed, was tested extensively in 1968 (see p. 281) on light soil. A similar trial on heavier land at Broom's Barn tested its effects on germination and growth, and compared its effect on aphids and yellows with menazon seed dressings. The soil contained a few *Longidorus* and many *Tylenchorhynchus* (2150/litre), but no *Trichodorus*. Pelleted Sharpe's Klein Polybeet seed was sown on 9 April at 3-in. spacing; the treatments were 10% 'Temik' granules drilled in the furrow with the seed at 5·5, 11, 27 and 55 oz a.i./acre and menazon incorporated in pellets with the same seed at 4% by weight of seed before pelleting (2 oz a.i./acre).

Up to 27 oz of 'Temik' increased seedling and plant numbers, and seedling and plant vigour. With 55 oz, seedlings were fewer, but not enough to affect post-singling plant populations; seedlings were less vigorous and the cotyledon tips were scorched. With menazon, seedlings and plants were slightly fewer and the plants were less vigorous than the untreated throughout the season. Aphid populations increased rapidly about the last week of June and on 2 July there were 31 green wingless aphids/plant on the untreated plots. Yellows was patchily distributed over the trial, but averaged 18% and 45% on the untreated plots on 1 August and 4 September respectively. 'Temik' at 5·5, 11, 27 and 55 oz and menazon at 2 oz a.i./acre decreased aphid numbers by 86, 88, 99, 97 and 76% on 2 July and yellows incidence by 69, 38, 77, 86 and 41%. Untreated plots yielded 59 cwt sugar/acre. Menazon increased root size and sugar yield by 6·3%. 'Temik' increased both sugar content and root weights, and increased sugar yield by up to 15%, presumably largely by its effect on yellows.

Results in this trial, and in others where aphids occurred, showed that 'Temik' applied in the furrow with the seed can have an effect on aphids lasting for several months. 'Temik' was therefore compared with the menazon seed dressing applied commercially for all sugar-beet seed crops, in a trial drilled at Broom's Barn on 9 July; Anglo-Maribo Polyploid seed was drilled 1 in. deep at 2 in. spacing in 20 in. rows. The menazon seed-

https://doi.org/10.23637/ERADOC-1-123

dressing was applied to the seed at 4% by weight of active ingredient (5 oz a.i./acre) and the 'Temik' granules were drilled in the furrow with the seed at 2 and 7 oz a.i./acre. These treatments were compared with a standard demeton-S-methyl spray to the foliage on 25 July. 'Temik' decreased seedling numbers slightly.

Aphids infested the seedlings as they emerged. The 'Temik' granules (7 oz/acre) and especially the menazon seed-dressing kept plants almost free from both black and green aphids for 3–4 weeks after they emerged (Table 1); aphid populations were then declining on the plots without insecticides. Demeton-S-methyl spray controlled aphids well, but its effect persisted for only about 14 days. Menazon seed-dressing decreased yellows most (73%), 'Temik' at 7 oz/acre and demeton-S-methyl by about 50%, but 'Temik' at 2 oz by only 11%. (Dunning and Winder)

TABLE 1

Effect of insecticides on aphid populations and yellows on stecklings at Broom's Barn, 1968

	Total number wingless aphids (black and green) as % of control					% virus yellows
	25 July	30 July	5 Aug.	12 Aug.	20 Aug.	25 Oct.
Menazon seed-dressing (5 oz a.i.)	1	11	8	7	12	10
'Temik' 10% granules (2 oz a.i.)	46	92	50	79	150	33
'Temik' 10% granules (7 oz a.i.)	3	9	3	10	64	17
Demeton-S-methyl spray (3·5 oz a.i.)	—	1	2	34	71	18
					Control	37

Mangold clamp and weed survey. Each sugar factory fieldman checked five mangold clamps for infesting aphids during late April; of 484 clamps examined, 86 were lightly infested, 26 moderately and only 8 heavily. *Rhopalosiphoninus staphyleae* was in 94% of samples of infested mangold shoots sent to Broom's Barn, and *Myzus persicae* in 19%. *R. latysiphon* and *Macrosiphum euphorbiae* were each found in a single sample. Of 55 samples of aphids tested from clamps, those from six were infective with BYV and from seven with BMYV.

Aphids occurred on 40% of the weed samples collected by fieldmen from sheltered sites adjacent to mangold clamps or fields where beet was grown in 1967, about the average proportion infested during the past eight years. Eleven samples of chickweed or groundsel contained *M. persicae*, and 29 contained *M. ascalonicus*. Aphids from two samples of groundsel were infective with BMYV and from two samples of chickweed with BYV.

Winged aphids. On average only one quarter as many aphids were caught on each of eight sticky aphid traps as during 1967; catches in August and September exceeded those in 1967. Unusually many *M. persicae* were trapped during August, when few usually fly, and many were also trapped

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at Harpenden during July. The sudden appearance of virus yellows in beet crops in Huntingdonshire, Cambridgeshire and other parts of central England during early August suggests that winged aphids were unusually active in this region during July. Although the total number of *M. persicae* trapped in each year was similar, *A. fabae* averaged only 30 per trap in 1968 compared with 465 in 1967. (Heathcote)

Seed crops. Seventy-five per cent of samples of leaves and shoots from beet seed crops examined from mid-May to the end of June had no aphids. Black aphids were exceptionally few, and only one crop from Kent was heavily infested with *M. persicae*. Seven crops in Kent examined in mid-June averaged fewer than 2% of plants with yellows.

In June, 66 crops distributed in all seed-growing areas averaged 0·42% plants with yellows, fewer than for several years. However, during July and August steckling beds for the 1969 seed crop became infested with aphids when weather made spraying difficult, and yellows became prevalent in some open, direct-drilled, beds in Northamptonshire, Bedfordshire and the Cotswolds, more in beds sown in early July than those sown later. Stecklings in the Cotswolds raised under barley cover crops were free from yellows. The average incidence of yellows in the 121 steckling beds inspected was 0·6%, but in 11 open direct-drilled crops in the Cotswolds it was 2·5%. A fifth of all mangold steckling beds inspected showed an average of 0·6% plants with yellows. (Byford and Heathcote)

Effect of cultural factors on aphid populations. Plots of Sharpe's Klein E sown on 13 March, 8 April or 24 April were singled to give average plant populations of 49, 27 and 16 thousands/acre. The numbers of *M. persicae* on 4 July on early-sown plots ranged from an average of 5/plant in the densest to 40/plant in the sparsest plant stand; on the later-sown plots their numbers were also inversely proportional to the plant population. The numbers of *A. fabae* on the earliest-sown plants were also inversely related to the plant population, ranging from an average of 1–3/plant, but not consistently on the later-sown plants. *A. fabae* increased with lateness of sowing, with an average of 8/plant sown on 24 April, whereas *M. persicae* were most on plants sown on 8 April (average 66/plant). The percentage of plants with yellows was inversely related to the plant population. On 23 September, yellows was least prevalent on the plots sown on 13 March (9%) and most on those sown on 8 April (31%). Another trial, sown on 26 March, had fewer *M. persicae*/plant with increasing plant population from 19 to 64 thousands/acre, but plots with 9 and 19 thousands/acre had similar numbers of aphids/plant. Here, also, the percentage of plants infected with yellows increased from 3% to 45% as plant population diminished. (Heathcote)

Seedling pests and diseases

Defoliation. The trial described in last year's *Report* (p. 269) was repeated, with plots sub-divided to test the effect of a nitrogen dressing (120 units) applied to the seedbed. It was sown on 8 April and plots were defoliated

https://doi.org/10.23637/ERADOC-1-123

once at monthly intervals from May to August. Green aphids were numerous on the plots not defoliated (30 apterae/plant) in mid-July and many plants developed yellows. Seedbed N decreased yellows, as determined visually, from 81 to 47% of plants infested on the undefoliated plots and over the whole trial from 54 to 38%; it is not clear whether this was because N affected aphid infestation and virus infection, or because it masked symptoms.

Sugar yields at harvest on 12 November were, with and without nitrogen respectively; untreated 54·8 and 47·7 cwt/acre; 15 May defoliation 46·1 and 42·4 (15·9 and 11·1% decrease); 14 June 42·1 and 33·2 (23·4 and 30·4%); 16 July 38·4 and 29·6 (29·9 and 37·9%); 15 August 35·7 and 36·7 (34·9 and 23·1% decrease). Contrary to results in 1967, sugar percentage was little affected by removing leaves, of which the main effect was to change root size. With nitrogen the effects from defoliation paralleled those in 1967; without nitrogen they varied more, and on average yielded 13% less sugar and 65% less tops than with nitrogen.

Mangold fly control. At one site where 'Temik' was tested for controlling cyst eelworm (see p. 282), mangold fly larvae mined 8·2% of the untreated seedlings, but fewer than 0·2% with 'Temik' at 11–55 oz a.i./acre applied in the furrow with the seed.

Seed and soil treatment with insecticides. Nineteen trials in different areas tested various fungicides and insecticides incorporated experimentally during pelleting of Sharpe's Klein E seed by the Germain process; at one other site pesticides alone were tested in both Germain and Webb pellets. The results of incorporating nematicides in pelleted seed were very inconclusive. Dieldrin and γ-BHC were tested at 2000 ppm/raw seed weight in two positions, either on the seed before pelleting or in the outer layers of the pellet. The average insecticide content of the pellet was in the range 2000–2300 ppm of active ingredient on the seed (analysis by the British Sugar Corporation's Research Laboratory). The seed was pelleted in February and germination tests made during March and August in the laboratory showed no adverse effects from dieldrin, but γ-BHC produced many abnormal seedlings. Such seedlings were not noted in the field; indeed the γ-BHC treatment improved plant establishment. Seedlings/50 in. and plants/22 yd were: control (EMP steep only)—12·2 and 71·2; dieldrin inner—12·6 and 75·8; dieldrin outer—12·9 and 73·9; γ-BHC inner—12·5 and 76·0; γ-BHC outer—12·5 and 75·5.

At Littleport, Ely, pelleted seed was tested on heavy fen soil where millipedes (mainly *Blaniulus guttulatus*) were prevalent, at least 50000/acre. Plots were drilled on 8 April. On 7 May nearly 90% of the seedlings had their roots damaged by millipedes and 75% had been bitten by pigmy beetles; nevertheless, only γ-BHC, especially when in the outer pellet layer, increased seedling establishment. Final plant population was not affected by any treatment. Amono seed was pelleted, by the Webb process, incorporating 'Temik' or 'Lannate' at $\frac{1}{4}$, 1 and 4% by weight of active ingredient on the raw seed; 4% of either material severely depressed germination in the laboratory but had little effect on the number of seed-

https://doi.org/10.23637/ERADOC-1-123

lings that emerged in the glasshouse or in the field at Broom's Barn. At Littleport 1% and 4% 'Lannate' improved seedling establishment and plant vigour, probably because it lessened root damage by pigmy beetle.

At the same site liquid formulations of DDT, γ-BHC, 'Lannate', chlorfenvinphos, 'Mobam', 'Boots RD 18502', 'Ciba C 10015' and 'C 14421' were trickled at ¼ and 1 lb a.i./acre in the furrow with the seed. Both amounts of chlorfenvinphos damaged seedlings but DDT, 'Lannate' and 'Mobam' at 0·25 lb/acre and γ-BHC and 'Ciba C 10015' at 0·25 and 1 lb/acre, greatly increased seedling and plant populations. Granular formulations of some of these and other insecticides were also tested in the furrow with the seed. 'Mocap' and 'Terracur' at either 6 or 30 oz a.i./acre damaged the seedlings. 'Dursban' at 16 oz/acre, 'Mobam' at 19 oz, 'Lannate' at 12 oz and 'Temik' at 18 oz greatly increased seedling and plant populations. 'Ciba C 10015', 'Lannate' and γ-BHC liquids, and 'Lannate' granules, decreased damage to the seedling roots by millipedes and pigmy mangold beetles. (Dunning and Winder)

Seed and soil treatments with fungicides. Trials at 19 centres compared EMP steep with maneb applied to the seed before pelleting, and with 'Phygon' (dichlone) applied to EMP-steeped seed in either the inner or outer layers of the pellet. Differences between the effects of treatments were small. Maneb gave 5·7% fewer seedlings than EMP steep, but 3·3% more plants in the final stand. Dichlone averaged 0·4% fewer seedlings and 2·3% more plants in the final stand than with EMP steep alone. One object of the trials was to determine whether there are some fields in which sugar beet will respond to the use of a protectant fungicide at drilling, but at only one site did dichlone give significantly more plants in the final stand than EMP alone.

At Broom's Barn, solutions of several fungicides were put in the furrow at drilling. Materials used included dichlone, captan, 'Difolotan' (captafol), 'Dexon', thiram, maneb and PCNB, but none obviously increased seedling emergence, final plant population or yield. 'Dexon' at 2 lb a.i./acre halved seedling emergence and decreased final plant population by 15·9% compared with the untreated control (34100/acre), but did not affect yield.

None of these fungicides, applied as dusts to seed, increased emergence as much as did EMP steep. Only captafol, thiram and two experimental materials slightly increased emergence when applied to EMP steeped seed.

In another trial, EMP steep gave 29·2% more seedlings than untreated seed, whereas an organo-mercury dust gave 15·6%, thiram steep 7·3%, 'Fernacol' steep 26·7%, maneb dust at 15 oz/cwt 18·8% and maneb slurry at 24 oz/cwt 27·7% more seedlings than untreated seed. (Byford)

Leaf diseases

Downy mildew. In 66 seed crops examined the average percentage of plants infected was 0·33%. The disease spread only little to root crops. Despite the wet weather in late summer, steckling beds also contained few infected plants in October; 121 beds inspected averaged 0·002% plants infected.

The relative resistance of sugar-beet varieties to downy mildew was

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again compared, in co-operation with the National Institute of Agricultural Botany at their regional centre at Trawscoed, Cardiganshire, in a field where the disease was encouraged. The total proportion of plants infected during the season ranged between varieties from 22% to 57%. The commercial varieties with fewest infected plants were Anglo-Maribo Poly, Monotri, Amono and Sharpe's Klein Polybeet; those with most were K. W. Erta, Bush Mono, Hilleshog and Bush-Johnson's E. The results agreed well with results in 1965–67, and a grading for mildew resistance is now included in the N.I.A.B. recommended list of sugar-beet varieties. Part of the trial area at Trawscoed was used by commercial plant breeders to screen lines for resistance to downy mildew at an early stage of selection.

Single rows of 5 varieties were sown at 26 sites in root crops near seed crops in south Lincolnshire, West Norfolk and Cambridgeshire. Mildew was rare at most sites. Excluding five sites where mildew was not found, the mean proportion of plants infected was: Sharpe's Klein E 1·4%, Sharpe's Klein Polybeet 1·4%, Anglo-Maribo Poly 1·7%, Maris Vanguard 2·9% and Hilleshog 3·9%; this is in general agreement with the results at Trawscoed.

A trial at Broom's Barn, singled to give 35000 plants/acre, tested the ability of surviving plants to compensate in yield for plants lost after singling. Removing alternate plants during the first week of June did not decrease yield. Removing alternate plants during the first week of July did not decrease yield either, but removing alternate pairs of plants decreased yield by 7%. Removing alternate plants in the first week of August decreased yield by 23%, and removing alternate pairs of plants decreased it by 21%.

***Ramularia* leaf spot.** This disease, which was again widespread in seed crops, defoliated many in the Cotswolds during July. It was also severe in some crops in south Lincolnshire, and occurred, but did not defoliate crops in Bedfordshire. Some root crops in south Lincolnshire were also severely affected during October and November.

A trial in an open direct-drilled seed crop at Chipping Norton, Oxfordshire, tested the effect of fungicides to control it. Plants were given 1–3 sprays of fentin hydroxide at 0·3 or 0·6 lb a.i./acre or three sprays with copper oxyquinolate at 0·5 lb a.i./acre between 1 April and 27 May. In late July, leaf spot was assessed by two methods; (i) visually on a 1–5 scale, in which where 1 was still green although most leaves had spots, and 5 had most plants defoliated or heavily spotted; (ii) mid-stem leaves were taken from 100 plants in each plot and the percentage of leaf surface covered by spots estimated. The treatment means ranged from 1% to 10%. Both methods gave the treatments in the same order of effectiveness, but the second method was much more laborious than the first. The most effective treatments were three sprays with fentin hydroxide at 0·6 lb a.i./acre and two late sprays with this material, which increased seed yield by 13% and 15% respectively. Two fentin hydroxide sprays which did not include the final spray on 27 May, and copper oxyquinolate sprays had little effect on leaf spot. (Byford).

https://doi.org/10.23637/ERADOC-1-123

Docking disorder

Fieldmen reported about 2300 acres of sugar beet with Docking disorder by the end of July, much less than in 1967. The worst affected factory areas were again King's Lynn (687 acres) and York (464 acres). Although much rain fell during the summer, the spring was generally dry, and conditions favouring nematode activity occurred when the beet had passed the seedling stage.

Survey. An annual survey was started to seek associations between Docking disorder and nematode numbers in the soil at drilling, soil type, rainfall and some other factors. Sixty fields in 14 factory areas were surveyed; these were chosen as likely sites for the disorder, but few of the crops actually developed it. There was no obvious relationship between crop yield and nematode numbers in the seedbed, although the only two fields with more than 1000 *Trichodorus*/litre of soil yielded poorly and produced fangy roots. *Trichodorus* spp. occurred in 75% of the fields (average 330/litre of soil) and *Longidorus* spp. in 59% (average 24/litre of soil). The pH of the soils ranged between 5·1 and 8·4 (average 7·1) and was not correlated with prevalence of any nematode genus. *Trichodorus* and *Longidorus* did not occur in the only site with more clay than 15%, but did in soil with up to 14% clay. (Cooke)

Viruses. Samples of stunted beet from 50 of the Docking disorder survey sites were tested for soil-borne viruses during July or early August. Each sample consisted of ten small entire plants and any with leaf-blotch symptoms were included. Sap from roots was inoculated to *Chenopodium amaranticolor*. Five samples, from Ipswich, Brigg, Bury St. Edmunds, Selby and Cantley factory areas contained plants infected with tobacco rattle virus, and two from Bury and Kidderminster with tomato black-ring virus. All but one of the samples shown to include TRV had at least one plant showing leaf-blotch symptoms, but the presence of the virus was not confirmed in eleven samples that included plants with leaf-blotch symptoms. (Heathcote)

Herringswell Rotation Experiment. In the third and final year of this experiment (see *Rothamsted Report for 1966*, p. 283, and *for 1967*, p. 271) all plots were sown with sugar beet on 4 April. The weather favoured sugar beet and Docking disorder did not develop. The average yield was 21½ tons of roots, which at 17% sugar content gave 73½ cwt sugar/acre, a striking contrast with the 15 cwt/acre obtained in 1965 when the crop was stunted with Docking disorder.

Although the crop was vigorous on all plots, yield was increased by fumigating the soil during the winter with dichloropropane-dichloropropene ('D-D') at 33·5 gal/acre (Table 2). The mean effect of fumigation in January 1966 on beet grown in rotation with other crops was to increase sugar yield by 9·4 cwt/acre, and fumigation in 1968 increased yield by 12·1 cwt/acre. The effect of again fumigating plots fumigated in 1966 was small (4·0 cwt/acre). The average response to a top dressing of 50 units/acre N, in addition to the 100 units given to the seedbed, was 1·5 cwt/acre

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of sugar. Unfumigated plots with the extra N yielded about 6 cwt/acre less than the fumigated plots; on the unfumigated plots the extra N gave 2·7 cwt/acre, on the plots fumigated in 1966 it gave 3·6 cwt/acre and on the plots fumigated in 1968, 0·5 cwt/acre of sugar.

TABLE 2

Yields of sugar (cwt/acre) in the Herringswell Rotation Experiment, 1968

From beet following a rotation crop

1966 fumigation	1968 fumigation: Not fumigated	Fumigated	Mean
Not fumigated	64·8	76·9	70·8
Fumigated	74·2	78·2	76·2
Mean	69·5	77·5	73·5

S.E.'s: V ±0·82 HI ±0·58 Mean ±0·58

From beet following beet

1966 fumigation	1967 fumigation: Not fumigated	Fumigated	Mean
Not fumigated	65·8	75·4	70·6
Fumigated	76·3	76·1	76·2
Mean	71·1	75·8	73·4

S.E.'s: V ±0·63 HI ±0·44 Mean ±0·44

On other plots in the experiment beet followed beet in 1967. Some of these plots were fumigated in 1967 or in 1966, but none was fumigated in 1968. The 1968 beet responded to the 1966 fumigation; unfumigated plots gave 65·8 cwt/acre and fumigated 76·3 cwt/acre. Plots fumigated in 1967 but not in 1966 yielded 75·4 cwt/acre, nearly 10 cwt more than unfumigated plots. Those fumigated in both years gave similar yield (76·1 cwt/acre) to those fumigated in 1966 only (76·3 cwt/acre). Different crop rotations did not affect yield on fumigated or unfumigated plots. In contrast to the results from the crop rotation experiment on Broom's Barn Farm (see p. 293), beet after two ryegrass crops yielded equally to that after any other crop, whether or not the land was fumigated.

Soil nitrogen status. Similar nitrogen determinations to those described in last year's Report (p. 272) were again made to study the part played by nitrogen in crop responses to 'D-D' (Table 3).

TABLE 3

Ammonium and nitrate nitrogen in soil in May 1968 at Herringswell

Sampling depth:	0–4½ in.	4½–9 in.	9–24 in.
		lb/acre in.	
Fumigated in			
1965	4·0	7·8	4·4
1966	3·8	7·6	4·4
1967	8·7	9·2	5·4
1965 and 1966	4·8	8·0	6·5
1965 and 1967	8·2	9·2	4·0
Unfumigated	4·0	9·3	4·4

Fumigation in the previous winter (1967) doubled the amount of mineral nitrogen in the surface 4½ in. There was little difference in mineral

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nitrogen between unfumigated plots and those fumigated in earlier years showing there was much less leaching in this dry spring than in 1967, which partly accounts for the large yields on the unfumigated plots this year.

Nematodes. *Longidorus attenuatus* reproduces slowly and by August 1968 populations in plots fumigated in 1966 were only 17·5% of those in unfumigated plots. The smaller population (average 10/litre of soil) in the fumigated plots possibly explains the increased yields from the fumigation in 1966. *Tylenchorhynchus* is the most abundant plant parasitic nematode in this soil. It was most numerous (7900/litre) in April in plots cropped with ryegrass—populations in April after other cropping did not exceed 2000/litre. Populations in the plots fumigated in 1966 had risen by April 1968 to 71% of those in unfumigated plots. *Pratylenchus* was also most numerous after ryegrass (5800/litre in April). The plots that carried sugar beet and potatoes in 1967 had populations of about 2100/litre in April 1968 and those that carried wheat or barley had fewer than 1000/litre. Plots fumigated in 1966 had 43% as many as unfumigated plots in April 1968 and 74% by August. Of other plant parasitic nematodes, *Trichodorus* did not increase in any plots, although soil type and weather seemed favourable; the population nowhere exceeded 180/litre by August 1968. *Hemicycliophora* was most abundant (up to 1000/litre) in plots cropped for two years with ryegrass.

Nematodes that are not obligate plant parasites (e.g. *Aphelenchus*, Rhabditida) were less affected than the parasites by fumigation and one year after fumigation populations equalled or exceeded those in unfumigated plots.

A few patches of the trial area were infested with the fungus *Helicobasidium purpureum* and on some unfumigated plots up to 23% of roots had violet root rot. The disease was controlled by soil fumigation; none of the plots fumigated at any time during the trial had more than 3·2% of roots affected. (Cooke, Draycott and Hull)

Nitrogen and fumigation. Effects of fumigation and N fertiliser were again tested on sites prone to Docking disorder in the York, Brigg, King's Lynn, Cantley and Bury St. Edmunds factory areas (*Rothamsted Report for 1967*, p. 274). Fumigation with 33·5 gal/acre of 'D-D' in December controlled all plant parasitic nematodes in the surface 8 in. of soil (Table 4), and they increased little during the year; by August numbers of *Trichodorus* in fumigated plots never exceeded 5% of those in unfumigated plots.

In April there were few *Trichodorus*, fewer than 300/litre in the surface

TABLE 4

Average numbers of nematodes/litre of soil in five experiments

	April		August	
	Unfumigated	Fumigated	Unfumigated	Fumigated
Trichodorus	642	10	1430	28
*Longidorus**	29·8	0·2	16·9	0·3
Pratylenchus	314	24	406	35
Tylenchorhynchus	1108	95	768	32

* Bury St. Edmunds, Cantley and King's Lynn only.

https://doi.org/10.23637/ERADOC-1-123

2 in. of soil in unfumigated plots, but up to 2000/litre in deeper layers. All plant-parasitic genera remained numerous through the wet summer, and even the surface of the soil was wet enough to provide a suitable habitat. The top 2 in. at the Cantley and King's Lynn sites had more than 2000 *Trichodorus*/litre during August.

Most of the rain fell after the critical seedling stage so, although some plots had Docking disorder, the symptoms were less severe than in 1967. Early in the season fumigation increased plant vigour, but the effect later disappeared at most sites and the nematodes, though numerous, seemed to affect the beet less than in 1967. However, the damage to growing plants in unfumigated plots gave fangier roots and significantly smaller yields than in fumigated plots.

Unfumigated plots needed less N to give maximum yield than in 1967, probably because roots were less damaged and less N was leached from the soil during spring. Unfumigated plots yielded most sugar when given 1·32 cwt/acre N (Table 5); fumigated plots needed about 0·66 cwt/acre. This confirms that fumigation with 'D-D' decreases the need for fertiliser N, partly by mineralising soil N and partly by improving the rooting system. (Draycott and Cooke)

TABLE 5

Mean effect of N and fumigation with 'D-D' on sugar yield at four sites affected by Docking disorder

Nitrogen dressing (cwt/acre)	0	0·66	1·32	1·98
		Sugar yield (cwt/acre)		
Not fumigated	32·3	44·3	49·0	47·5
Fumigated	49·7	60·1	55·1	57·4

Nematicide trials. Soil from Thornton, Yorks., infested with *Trichodorus anemones* was mixed by churning for four minutes with 'Temik' 10% granules to give concentrations of 0·1, 1·0, 10, 100 and 1000 ppm. Six seeds of Sharpe's Klein E rubbed and graded 8–10/64 in., EMP-steeped but not treated with insecticide, were sown on 8 February in the treated soil, and in a similarly churned soil without 'Temik', in two litre pots of black polythene. The pots were kept in a glasshouse (mean maximum temperature 72° F, mean minimum 48° F) and watered to their original weight with the soil at field capacity.

'Temik' at 1000 ppm prevented seedlings from emerging and at 100 ppm severely retarded the growth of seedlings. Smaller concentrations increased seedling vigour and improved root shape, but had no effect on root weight (Table 6); 1 ppm, which gave the best results, is equivalent to 4 oz a.i./acre assuming it is applied in rows of cross-sectional area of 3 in. × 5 in.

Further lots of these soils were prepared and watered as above, and then kept at a temperature of 54–58° F. Immediately after churning, 4550 *Trichodorus*/litre were extracted from the soil with no 'Temik'. A week later 4435 were extracted from the soil and 2935, 2350, 1915 and 1600, from samples containing 0·1, 1·0, 10 and 100 ppm 'Temik'; a second extraction after a further 3 weeks yielded 2985 from soil without 'Temik' and 1815, 1450, 1015 and 985 from that with.

https://doi.org/10.23637/ERADOC-1-123

TABLE 6

Effect of 'Temik' in the soil on sugar beet in pots

	'Temik' (ppm)				
Assessment	0	0·1	1	10	100†
Seedlings/pot, 25 Feb. (pre-singling)	7·7	7·7	8·0	6·2	5·7
Leaf length (in.) 18 March	1·2	1·9***	2·0***	2·0***	0·5
Score for root shape 29 April. (0 = perfect; 5 = very fangy)	2·1	0·3***	0·6***	0·5***	0·9
Average root weight (g)	3·2	3·5	3·8	3·2	0·3

† 100 ppm. Figures not included in statistical analysis.
*, **, *** Significantly different from the control at the 5%, 1% and 0·1% levels of probability.

'Temik' 10% granules, drilled in the furrow with the seed, were tested at 10 sites where Docking disorder was expected in fields of sandy soil. The sites, numbers of *Longidorus* and *Trichodorus*/litre of soil at the time of drilling and the drilling date were: in East Anglia: Larling, 130, 550, 19 March; Hellesdon, 25, 2850, 22 March; Swaffham, 85, 200, 30 March; Herringswell, 50, 100, 4 April; Gayton Thorpe, 0, 250, 6 April; Hockwold, 250, 50, 17 April; in north Lincolnshire: Messingham, 0, 600, 27 March; in Yorkshire: Holme upon Spalding Moor, 0, 200, 5 April; Raskelf, 0, 650, 22 April; in Shropshire; Shifnal, 250, 200, 9 April. Varieties differed at different places, seed spacing ranged from 2 to 4·5 in. and pH from 5·4 at Holme, where lime was applied after drilling, to 8·1 at Gayton Thorpe. Little rain fell in April, May and June, and Docking disorder symptoms developed only at Gayton Thorpe (moderately) and Hockwold, Messingham and Raskelf (slightly).

'Temik' at 2, 4, 9 and 18 oz a.i./acre was applied to rows 20 in. apart in most of the trials, but 6, 11, 27 and 55 oz a.i./acre were applied at Hockwold where the soil contained much peat. 'Lannate' 5% granules at from 2·5 to 36 oz a.i./acre were also tested at Holme, Raskelf and Shifnal; except at 2·5 oz, 'Lannate' was damaging, and decreased seedling and plant populations, vigour and yield. These results differ from those obtained with an aqueous solution of 'Lannate' in 1967. Both granule and solution were compared in other trials detailed later.

Seedling numbers and plant populations after singling were unaffected by 'Temik'. Plant vigour, assessed by scoring at intervals between May and August, was usually improved, especially during May and June. This effect was greatest at Gayton Thorpe, where vigour increased with increasing amounts of 'Temik', at Larling, Herringswell, Hellesdon and Holme.

Despite the mildness or lack of symptoms of Docking disorder, 'Temik' increased sugar yield at most sites; on average 2, 4, 9 and 18 oz by 2·4, 6·5, 4·9 and 7·6% respectively. At sites where yield was most increased sugar yields (cwt/acre) without 'Temik' and with the four amounts were: Hellesdon 54·1, 55·8, 57·2*, 56·2, 56·8*; Gayton Thorpe 35·9, 40·6*, 40·1, 42·5**, 44·2**; Messingham 61·3, 65·2, 67·0, 64·3, 69·9*; Holme 47·8, not tested, 51·9*, not tested, 49·9; Raskelf 43·6, not tested, 48·0, 45·2, 44·8. At

https://doi.org/10.23637/ERADOC-1-123

Hockwold, where only two blocks of a 5 × 5 Latin square could be harvested, 'Temik' (oz/acre) and sugar yield (cwt/acre) were 0, 40·6; 6, 46·2; 11, 50·0; 27, 44·5; and 55, 47·6.

At harvest the roots were scored for fanginess on a scale 0 = perfect, 5 = very fangy. Root shape was most improved at Gayton Thorpe where the scores were 1·96 without 'Temik' and 1·20***, 0·92***, 0·98*** and 0·84*** with 2, 4, 9 and 18 oz a.i./acre respectively. At Raskelf root shape was greatly improved, and slightly at most other sites. Averaging all sites 9 oz a.i./acre of 'Temik' applied in the furrow with the seed gave the best root shapes.

The *Trichodorus* were extracted from soil samples, taken in the row to 8 in. depth at harvest, from untreated plots and those treated with 9 oz; also in some trials with 18 oz a.i./acre 'Temik'. Omitting sites where control plots had fewer than 1000/litre, the numbers extracted were, respectively with 0, 9 and 18 oz of 'Temik', Hellesdon 3250, 3000 and 1300; Messingham 1000, 450 and 450; Gayton Thorpe 1550 and 650 and Raskelf 2700 and 1900 (18 oz not sampled). Without 'Temik', populations increased during the season at these four sites, but remained static or decreased at the other sites.

The benefits from 'Temik' were much less than in 1967 (*Rothamsted Report for 1967*, p. 276–278), largely because Docking disorder was much less, but perhaps also partly because the 'Temik' moved less down through the soil during the dry spring.

Several possible nematicides were tested, either as solutions or as granules, drilled in the row with the seed in single rows at Broom's Barn and most of the Docking disorder trial sites. 'Mocap', chlorfenvinphos, PP 511, 'Terracur' and, as previously, thionazin damaged the beet seedlings. 'Boots RD 18502', 'Ciba 14421' and 'Niagara 10242' (furadan) warrant further testing. 'Lannate' solution seemed less damaging than the granules. (Dunning and Winder).

Two experiments were made to test whether pesticides and fungicides would affect the Barney type of Docking disorder, but they produced no useful results because the trouble did not develop where it was severe in 1967. (Byford and Dunning)

Cyst eelworm

'Temik' granules drilled in the furrow with the seed were tested in two fields where beet was grown under licence and cyst eelworm, *Heterodera schachtii*, was damaging in 1967. The soil at Burnt Fen, Mildenhall, was a peat fen containing 372 eggs/g and at Sutton, Ely, a clay fen containing 148 eggs/g when the trials were drilled on 29 March and 10 April respectively with pelleted Sharpe's Klein E seed. Table 7 gives seedling populations, white cyst numbers and sugar yield.

'Temik' at 55 oz a.i./acre slightly damaged seedlings at both sites, decreasing seedling numbers and, at Sutton, seedling vigour during May; foliage vigour improved later, and by August plots given this treatment were the best. The smaller amounts of 'Temik' increased seedling numbers, and gave plants with more vigorous foliage than the untreated ones

https://doi.org/10.23637/ERADOC-1-123

throughout the season. 'Temik' did not affect plant populations after singling. At both sites damage from the many cyst eelworms was severe, and, although the tops were vigorous, sugar yield was small. 'Temik' slightly decreased root fanginess at harvest and at 11 oz increased sugar yield by up to 29% at Sutton and at 55 oz by 42% at Burnt Fen. It made cyst numbers fewer during the summer; effect on final cyst and egg numbers are not yet known.

TABLE 7

Effect of 'Temik' on sugar beet in fields with cyst-eelworm

	Burnt Fen			Sutton		
'Temik' (oz a.i./acre)	Seedlings/ yard	White cysts/ root 25 June	Sugar yield cwt/ acre	Seedlings/ yard	White cysts/ root 4 July	Sugar yield cwt/ acre
0	16·4	174	24·7	11·6	107	20·7
5·6	16·6	—	29·8	—	—	—
11	17·2	—	32·2	12·9	28	26·7
27	16·6	47	33·3	12·9	10	25·3
55	15·7	—	35·0	10·2	10	23·7
35*	—	—	—	12·6	10	26·2

* 11 oz a.i. in furrow with seed plus 12 oz a.i. in surface soil immediately on either side of row.

'Lannate' (*S*-methyl *N*-((methylcarbamoyl) oxy) thioacetimidate) as 5% granules, applied in the row, was also tested at Burnt Fen at 9, 18 and 36 oz a.i./acre. The two largest amounts not only decreased seedling and plant populations, but also vigour and yield. With 9 oz seedlings were slightly fewer, but plant populations after singling were unaffected; sugar yield was increased only 4%. (Dunning and Winder)

Seed production

Field experiments at Chipping Norton and Over Norton, Oxon., and at Sutton St. James, Lincs., tested how various cultural practices affect seed yield and quality. The plants were harvested by hand, placed in hessian sacks and taken to Broom's Barn for drying and threshing. Yields comprise all seed recovered from a winnower and passed between 20/64 in. and 7/64 in. round hole sieves, corrected to 15% moisture content and 97% purity. This harvesting procedure gives samples containing more smaller, lighter seeds than does cleaning to commercial standards, and so yields are larger and germination percentages, smaller. The object is to retrieve the whole range of seed for further study. The proportion of a sample of seed that germinates can be increased from 50 to 75% by rejecting 35% by weight of the smallest seed.

Time of sowing and harvest. At Chipping Norton plots of a multigerm seed crop were sown on three occasions in 1967 for harvesting on three occasions in 1968. A spray of pyrazon in April checked the growth of chickweed, which was most vigorous on the late-drilled plots. Less seed

https://doi.org/10.23637/ERADOC-1-123

was harvested on 29 August 1968 from plots sown on 18 August than from those sown on 19 July or 3 July. When harvested on 5 September or 12 September, plots sown on different occasions yielded similarly. Harvest date did not affect the yield of seed from sowings made on 3 July or 19 July, but plots sown on 18 August yielded 19·1 cwt/acre ($\pm$1·01) when harvested on 29 August, and 22·8 cwt/acre ($\pm$0·72) when harvested on 5 or 12 September. The seed with the best germination was harvested on 12 September from a sowing made on 19 July, significantly better than from sowing on 18 August, but not from sowing on 3 July. Delaying harvest from 29 August to 5 September, or from 5 to 12 September, also increased germination percentage.

At Over Norton plots of a monogerm seed crop were sown on three occasions in 1967 for harvest on three occasions in 1968. The latest sowing was sprayed with pyrazon in April to control weeds. Yields of seed decreased significantly between harvests on 12 and 19 September from sowings on 29 June and 19 July, but not from ones made on 18 August. At each harvest sowings on 18 August yielded significantly less seed than sowings on 19 July or 29 June 1967. Sowings on 29 June gave more seed than sowings on 19 July when harvested on 5 September 1968, but the differences with harvests later than this were not significant. The proportion, but not the absolute weight of seed, in the smaller size grades increased with later harvests, presumably because some of the larger, riper seed shattered. Sowing dates had no effect on seed size-grade distribution. Seed harvested on 12 or 19 September had similar percentage germination, more than seed harvested on 5 September. Seed harvested from plots sown on 18 August germinated less well than seed from plots sown on 19 July or 29 June. Percentage monogermity was greater in seed harvested from plots sown on 29 June than from ones sown on 19 July or 18 August, and less in seed harvested on 5 September than on 12 or 19 September.

Fertilisers for the seed crop. The effects of fertilisers in 12 different combinations applied to the seed bed before sowing, or to the crop next spring, were assessed with a multigerm seed crop sown on Oolitic limestone at Chipping Norton, Oxon., on 3 July 1967 and harvested on 5 September 1968. All plots had a basal dressing of 0·75 cwt N/acre. Plot treatments supplied N at 1·0, 1·5 or 2·0 cwt/acre as 'Nitro-Chalk', P_2O_5 at 0·75 or 1·5 cwt/acre as superphosphate, K_2O at 0·75 or 1·5 cwt/acre as muriate of potash and agricultural salt at 0 or 3·0 cwt/acre. Plots given 1·5 cwt/acre P_2O_5, 1·5 cwt/acre K_2O and 3·0 cwt/acre salt before drilling, plus 1·5 cwt/acre N the next spring, yielded most seed. The yield of seed from all plots with salt averaged 20·2 cwt/acre ($\pm$0·56), and from those without salt 18·3 cwt/acre ($\pm$0·29). Plots given 1·5 cwt/acre P_2O_5, 1·5 cwt/acre K_2O and 3·0 cwt/acre salt before drilling, plus 2·0 cwt/acre N next spring, gave seed with the largest germination percentage in this experiment, 47·0 ($\pm$ 1·44) (angular transformed). The mean germination of seed from all other plots was 43·3 ($\pm$ 0·87). These results suggest that salt may be important for direct-drilled seed crops.

The effects of eight different combinations of N and P_2O_5 fertilisers applied in the autumn or in the following spring were tested with a mono-

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germ seed crop sown under barley in deep fertile soil at Sutton St. James, Lincs., on 21 April 1967 and harvested on 27 and 28 August 1968. After removing the barley, all plots received N at 0·70 cwt/acre and K_2O at 2·0 cwt/acre. Treatments supplied N at 1·5, 2·0 or 2·5 cwt/acre and P_2O_5 at 0·75, 1·0 or 1·5 cwt/acre. The yield of seed from plots given 1·5 cwt/acre P_2O_5 in the autumn, plus 2·0 cwt/acre N and 1·0 cwt/acre P_2O_5 next spring, was 30·0 cwt/acre ($\pm$1·04), whereas plots given 1·5 cwt/acre P_2O_5 in the autumn and 2·5 cwt/acre N in the spring yielded 26·3 cwt/acre ($\pm$1·04). Other treatment effects on yield were not significant and none of the treatments affected percentage germination, monogermity or size-grade distribution of the seed.

Plant population. At Over Norton, Oxon, monogerm seed was sown on 29 June in rows either 5, 10 or 20 in. apart, and the plants were thinned to approximately 2, 6 or 12 in. apart within the row. When harvested on 12 September, the six treatments aimed at a plant population of 104 000/acre or more yielded more than the two aimed to give 52000/acre, which yielded more than the one aimed to give 26000 plants/acre. Different plant arrangements with similar population/acre yielded similarly. Seed from closely spaced plants usually had a slightly larger germination percentage than seed from widely spaced plants. Percentage monogermity was not affected by plant spacing in the row but increased from 77 to 82 to 85% ($\pm$1·14) with increasing row width.

Pollen liberation. The pattern of pollen release from small plots of diploid and tetraploid beet transplanted in March was followed at Broom's Barn with a spore trap operated between 1 and 26 July; 48% of the season's total catch was trapped during four days before 9 July, 48% during 10 days when pollen was caught between 10 and 23 July and 4% during the three days 24–26 July. Very little pollen was caught during wet weather.

Less than 14% of the yield of seeds from male sterile plants growing near the spore trap came from parts of the plants where the flowers were open before 9 July, when almost half of the pollen had been shed. Further experiments are planned to investigate the reason for this.

Effects of harvest date and seed size. Two varieties harvested in different years had nearly normal distributions of seed size and the mean size increased progressively with later harvesting. Mean fruit weight within a size grade was not affected by harvest date, but increased with increase in maximum fruit diameter. In a size grade, the number of locules where embryos could develop were unaffected by harvest date, but increased with increase in fruit size from about 1·08 to 1·73 locules/fruit for the open-pollinated crop harvested in 1966 and from about 1·05 to 1·28 locules/fruit for the cross-pollinated crop harvested in 1967. The mean number of embryos in the fruits within a size grade was only slightly affected by harvest date but greatly by fruit size from 0·91 to 1·68 for the open-pollinated crop and from 0·97 to 1·29 for the cross-pollinated crop. Thus, the observed monogermity based on dissection of seed from the cross-pollinated crop, containing genetical monogerm and small multigerm

https://doi.org/10.23637/ERADOC-1-123

fruits, was similar with 8–9/64 in. diameter fruit and nearer to the desired value of 1·00 for 13–14/64 in. diameter fruit than that of the seed from the open-pollinated crop. When sown in compost, large fruit of both varieties produced more seedlings than small fruits, and late harvested seed produced more than early harvested. Seed larger than 12/64 in. diameter averaged more than 1 seedling/fruit. The ratio of emerging seedlings to embryos was greater from any one harvest as fruit size increased and within any one size grade with later harvesting. However, the ratio did not increase with increasing fruit diameter more than 10/64 in. when harvested during or after the last week in August. Differences in seed size did not affect the weight of seedlings of the open-pollinated variety when 15 days old, but those from seed harvested on 23 August were lighter than from seed harvested on 31 August and 6 September. Seedlings (12 days after sowing) of the cross-pollinated variety weighed more from large than from small seed harvested on each of three occasions, and with each size grade seedlings from seed harvested on 14 August weighed less than from later harvests. Thus the mean weight per seedling of both varieties increased with later harvests, but increased with seed size with only one variety.

Field plot size. Yields of seed on replicates of a treatment often differ considerably. More accurate experiments have been achieved by modifying the harvesting and threshing methods, and by increasing the number of replicates of treatments to 4 or 5. In 1968 three different lengths of plots were harvested to give yields from different plot areas. The coefficients of variation for shoot and seed yield (Table 8) suggest that harvest areas should not be less than 10 m² and little advantage was gained from plots exceeding 20 m². (Longden)

TABLE 8

Effects of harvest area on accuracy of results in experiments with sugar-beet seed crops

Expt. No.	Site	Variety	No. of replicates	Area harvested (m²)	Coefficient of variation (%) Shoot yield	Seed yield
1	Chipping Norton	Multigerm A	4	5·4	11·26	8·27
				16·2	8·11	9·82
3	Chipping Norton	Multigerm A	4	10·9	9·86	9·33
4	Over Norton	Monogerm A	5	10·9	10·22	9·95
				31·6	6·36	7·12
5	Over Norton	Monogerm A	5	2·7	—†	15·51
				10·9	—	8·07
				31·6	—	7·80
6	Sutton St. James	Monogerm B	5	15·2	6·26	8·14

† = no data.

Sugar-beet manuring

The experiments reported below dealing with peat remnant, N-Na dung and magnesium were done in co-operation with the British Sugar Corporation in 1967. Except where stated, all the other experiments were on Broom's Barn farm in 1968.

https://doi.org/10.23637/ERADOC-1-123

NPKNa on peat remnant. Six experiments were again done on Fenland fields where the peat layer had become so thin that the plough penetrated the clay subsoil. N was applied at 0, 0·6 and 1·2 cwt/acre; P_2O_5 at 0, 0·75 and 1·5 cwt/acre; K_2O at 0, 1·0 and 2·0 cwt/acre; NaCl at 0 and 3·0 cwt/acre. The four nutrients were applied to plots in a factorial design.

As usual on these organic soils the yield response to all nutrients was small. On average the best N dressing was 0·6 cwt/acre, although at two sites yields of sugar were largest without N fertiliser. At all sites there was a response to phosphate, but 0·75 cwt/acre P_2O_5 gave maximum yield. Responses to potash were small and irregular; 1·0 cwt/acre K_2O was enough at all sites. There was no response to agricultural salt at any site.

N-Na FYM. Six experiments were done in 1967, the fourth and final year. The object was to investigate how agricultural salt (5 cwt/acre) and FYM (12 tons/acre) affect the response to N. Sugar yields in 1967 confirmed earlier results; there was a positive interaction between Na and N without dung but not with, and response to N and Na was less with than without dung.

Table 9 shows the mean sugar yields from the 23 experiments made during the four years 1964–67. The optimal N dressing without FYM was 1·2 cwt/acre, and 0·6 cwt/acre with FYM.

TABLE 9

Mean sugar yields (cwt/acre) with and without FYM, 1964–67

N (cwt/acre)	0	0·6	1·2	1·8
		Without FYM		
Without salt	45·1	51·5	53·4	55·4
With salt	43·7	53·4	56·0	54·7
		With FYM		
Without salt	47·2	56·2	54·5	56·5
With salt	49·9	56·0	57·1	55·2

Form of fertiliser and time of application. Anhydrous ammonia and liquid fertilisers were again tested at Broom's Barn, on Brome Pin field. The ammonia was injected at 6 in. depth on three dates; 13 March on the ploughed land; 16 April on the partially prepared seedbed; 7 June injected along the rows before singling. These treatments were compared with N in the seedbed as 'Nitro-Chalk', as a liquid N fertiliser or as a compound liquid fertiliser. All fertiliser treatments supplied the same amounts of phosphate, potash and salt, and 1·0 cwt/acre N. Ammonia injected in the ploughed land gave 51·1 cwt/acre sugar, applied to the seedbed gave 55·8 cwt/acre, and injected during June gave 52·3 cwt/acre. As previously, yields with 'Nitro-Chalk' and the liquid sprays were similar to those with anhydrous ammonia in the seedbed.

Magnesium. Six experiments, on fields selected by fieldmen as likely to produce magnesium-deficient beet, tested in a factorial design 0, 2·5 and 5 cwt/acre kieserite and 1 ton/acre Dolomitic limestone; 0·8 and 1·2 cwt/acre N as 'Nitro-Chalk'; 0 and 3 cwt/acre salt. Beet at two sites showed

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severe deficiency symptoms, at two slight and at two none. On average kieserite increased the root yield by 0·5 ton/acre and sugar yield by 1·7 cwt/acre. Dolomitic limestone increased yield only slightly, as did the additional N dressing. Sugar yield was increased most by the salt.

Nineteen experiments of this design have now been completed during the period 1964–67. On average, kieserite and Dolomitic limestone increased sugar yield; the most effective dressing was 5 cwt/acre kieserite, which increased sugar by 3·1 cwt/acre. Agricultural salt and the larger dressing of N were profitable and neither interacted with magnesium on average.

Long-term effects of magnesium. Three experiments begun in 1966 were cropped with sugar beet in 1967; their design was described in *Rothamsted Report for 1966*, p. 292. Kieserite (5 cwt/acre) applied twelve months previously increased sugar yield more than when applied in the sugar-beet seedbed, confirming previous results; 2·5 cwt/acre had less effect than 5 cwt/acre. Farmyard manure and kainit greatly increased yield. (Draycott)

Magnesium uptake. The work begun at Broom's Barn in 1967 (*Rothamsted Report for 1967*, p. 286) was continued on fields where magnesium deficiency was expected. Samples of plants and soil were taken each month during the growing season from four experiments measuring the response to 5 cwt/acre kieserite. Most plants without kieserite had symptoms of deficiency at Ipswich (Table 10).

TABLE 10

Magnesium content of sugar-beet tops and plants with magnesium deficiency symptoms

	Without kieserite		With kieserite	
Sampling date	Mg concentration (%)	Plants with symptoms (%)	Mg concentration (%)	Plants with symptoms (%)
4 May	0·318	0	0·780	0
10 June	0·283	0	0·750	0
8 July	0·172	5	0·476	0
1 August	0·125	72	0·228	0
9 September	0·115	95	0·198	2

The magnesium concentration in plants decreased rapidly during spring, then more slowly during the summer and reached a constant value during the autumn. At all stages of growth the magnesium concentration and the percentage of plants with symptoms were very closely related. The 'critical concentration' in the sugar-beet tops at which symptoms appear and yield is decreased was about 0·20%. (Draycott and Durrant)

Sodium, magnesium and irrigation. A factorial experiment on Brome Pin field tested 0 and 5 cwt/acre agricultural salt, 0 and 5 cwt kieserite, and irrigation to a planned soil moisture deficit of 1·5 in. Samples of the beet from each plot were harvested each month from May to November. Neither magnesium fertiliser nor irrigation had much effect on yield; irrigation was needed only once and the 1·25 in. given was followed by

https://doi.org/10.23637/ERADOC-1-123

rain. In contrast, the salt significantly increased the growth and yield of the crop. At first, plants without salt grew faster than those with, but by early July this was reversed, and plants with salt yielded significantly more dry matter than those without. The dry matter yield of the roots was increased by salt at every sample harvest and the sugar yield was increased at final harvest by 3·2 cwt/acre. (Draycott)

Nitrogen requirement. Work started on the nitrogen requirement of sugar beet in relation to soil mineral-N, to plant mineral and total N; three sites selected to give a range of soil types were, a loamy sand in the Newark factory area, a shallow calcareous loam in the Felsted area and a loamy clay in the Nottingham area. Top soil and subsoil samples were taken in autumn 1967 and the winter, and each month during the growing season. Plants were also analysed each month from singling to harvest.

The calcareous loam always contained most mineral-N and released the most on incubation. Subsoil samples contained relatively little during the winter and released little on incubation—the calcareous loam contained the most and the loamy sand the least. Fertiliser-N was leached from the sandy loam during the early part of the growing season, and about 40 lb/acre N had leached below 3 ft by June.

Without fertiliser-N, the calcareous loam produced the largest yield of roots (18·9 ton/acre) and the sandy loam the smallest (16·3 ton/acre). However, with 0·99 cwt/acre N, all three sites yielded similarly. (Last)

Soil compaction. How soil compaction affects yield of sugar beet and response to fertilisers was studied at Saxmundham, on Grove Plot, and at Broom's Barn, on Bullrush field. The treatments were as described for Saxmundham in last year's Report (p. 242).

At Saxmundham the compacted seedbed gave less sugar (55·0 cwt/acre) than the seedbed kept as open as possible (59·5 cwt/acre). The rolled seedbed gave 56·8 cwt/acre. On average of the three seedbeds, 1·2 cwt/acre N gave the largest yield this year, and the extra dressing of phosphate significantly increased yield. Response to N was largest on the compacted plots, and there was a significant negative interaction between N and less compaction of the seedbed.

At Broom's Barn the compacted seedbed also gave less sugar (61·8 cwt/acre) than the seedbed kept open (63·5 cwt/acre). Rolling had little effect (63·8 cwt/acre). On average of the seedbed treatments, 1·2 cwt/acre N gave the largest yield, but response to N was small and not significant; the extra phosphate gave no response. As at Saxmundham there was an interaction between N and compaction of the seedbed. This may be because compaction limits rooting volume and the plants need to get more of their N from the top soil. (Draycott and Hull)

Plant spacing

Twin rows on ridges. The experiment described in last year's Report (p. 287) was repeated to compare pairs of rows (twins) of sugar beet 10 in. apart and 20 in. between adjacent rows of the twins, with single rows 20 in.

https://doi.org/10.23637/ERADOC-1-123

apart. The twin rows were sown either on a flat seedbed or on ridges thrown up in the winter at 30 in. centres with the apex flattened at drilling. The experiment was sown on Bull Rush field on 28 March with Monotri pelleted seed at 5 in. spacing. 'Pyramin', sprayed at 1·75 lb/acre at drilling, and 'Betanal', at 5 pt/acre on 29 May, kept the crop free from weeds without any hand or machine cultivating. The plants on the ridges did not tilt outwards as they did in 1967. Bolters averaged 1%. The plots were harvested by hand on 21 October.

The twin rows had similar plant populations on the ridges and on the flat and averaged 46500/acre; the 20 in. rows had 36900/acre. Applying N at different times had little effect, but the seedbed dressing gave slightly more roots, sugar percentage and sugar yield than the later dressing. Root yield averaged 18·7 tons/acre and sugar yield 64·7 cwt/acre. The experiment was very accurate with a main plot coefficient of variation for root yield of 2·56% and for sub-plots 3·16%. The 10 in. rows on ridges outyielded those on the flat by 1 ton/acre of roots and 3·9 cwt/acre of sugar, and outyielded the 20 in. rows by about ½ ton/acre of roots and 2·2 cwt/acre of sugar. It is interesting that the beet on ridges outyielded those on the flat. A similar effect in 1967 was confused by different plant populations. It suggests that ridging affects some soil factor that limits yield when the crop is grown on the flat and parallels the response to compaction (see p. 289) obtained on the experiment alongside.

Plant distribution pattern. On Brome Pin field Monotri pelleted seed was sown on 5 April at 10-in. spacing on rows 10 in. apart, at 14 in. by 7 in. or at 20 in. by 5 in. to give 1 seed/100 sq in. At a theoretical field emergence of 50% of seeds sown this would give about 30000 plants/acre. Establishment was better than this and the harvested plant population averaged 34·5 thousands/acre and did not differ with seeding pattern. The plots were sown either with the usual Stanhay 5 drill unit or with a special Stanhay synchronised drill designed to place the seeds in an alternating pattern in adjacent rows. The synchronised drill gave a more uniform distribution of plants than the other. The different plant spacings had no effect on sugar percent but 10-in., 14-in. and 20-in. rows yielded 28·8, 25·9 and 25·4 tons/acre of tops respectively on 22 November. The corresponding yields of roots were 21·4, 20·8 and 20·4 tons/acre, a trend towards greater yield from the narrower spacings but not a significant difference. The closer rows gave roots more uniform in size, with fewer exceeding 12 cm diameter and fewer less than 7 cm diameter. Sugar yields from the three row spacings were 10 in., 68·5; 14 in., 67·1 and 20 in., 65·4 cwt/acre.

Sowing date and plant population. Plots of Sharpe's Klein E sown on 13 March, 8 April or 24 April in 20-in. rows were singled at 6 in., 12 in. or 20 in. Similar experiments were described in *Rothamsted Reports for 1964*, p. 268; *for 1965*, p. 277; *for* 1966, p. 295 and *for 1967*, p. 288. The plots were harvested on 28 November (Table 11).

Sugar yield was increased by earlier sowing but was unaffected by the wide range of plant populations. The widest-spaced plants contained less sugar (15·5%) than those spaced at 6 in. (15·9%) or 12 in. (15·8%), and

https://doi.org/10.23637/ERADOC-1-123

TABLE 11

Effect of plant spacing and sowing date on sugar yields (cwt/acre)

Plant spacing	6 in.	12 in.	20 in.	Mean
Plants 1000/acre	48·2	26·6	15·9	30·2
Date sown				
13 March	72·5	74·2	72·6	73·1
8 April	66·0	62·5	57·6	62·1
24 April	53·2	58·0	55·9	55·7
Mean	63·9	64·9	62·0	63·6

they contained more juice impurities. Root yield was decreased more by the dense plant stand at the last than at the first and second sowings. (Hull and Webb)

Nitrogen, spacing and irrigation. This experiment was to see how density of plant stand, nitrogen fertiliser and irrigation affect yield and moisture-use of sugar beet. The plant populations (7·5, 15, 30 and 55 thousands/acre) and nitrogen treatments (0, 0·6, 1·2 and 1·8 cwt/acre N) were as before (*Rothamsted Reports for 1966*, p. 296 and *for 1967*, p. 288). In contrast to 1967, the early part of the growing season was dry and the calculated water deficit was 1 in. at the end of May. Rainfall was equal to transpiration and evaporation until July, when a dry spell increased the calculated deficit to 2 in. and 1·25 in. of water was given. Thereafter, until the end of August, rain exceeded transpiration and abolished the deficit. There was a short dry spell during late August/early September, but irrigation was not required and rain in September again abolished the deficit.

The moisture in the soil to a depth of 4 ft was measured every two weeks using neutron moderation. The deficits obtained from these observations agreed well with the estimated ones. As in 1967, the large population of beets consistently used more water than the small one, at first because of the much larger leaf cover. However, the large population also used more water than the small population later in the summer when the leaf covers were similar.

Irrigation did not affect sugar yield. The mean yields from the four spacings were: S1—48·0, S2—61·9, S3—64·3 and S4—63·8 cwt/acre, and from the N dressings were: N0—49·9, N1—61·4, N2—64·6 and N3—61·4 cwt/acre. (Draycott)

Time of sowing and harvesting

Three dates of sowing and harvesting var. Sharpe's Klein E were tested on Brome Pin field; the experiment was modified to include tests of 0, 0·6, 1·2 or 1·8 cwt/acre of N as 'Nitro-Chalk' applied on the seedbed. Plant population, which averaged 34000/acre, ranged from 33 to 35 thousands/acre and was decreased by 1800/acre by the largest N dressing. Bolters averaged 1% on the early sowing. Root yields from the four nitrogen dressings averaged 16·9, 17·8, 18·6 and 18·8 tons/acre; sugar yields were 52·3, 55·6, 56·5 and 56·2 cwt/acre, and the sugar contents 15·6, 15·6, 15·2 and 14·9%. There was no significant interaction between N, sowing date and harvest date for any of these attributes. Earlier sowing greatly increased yield but did not influence sugar percentage (Table 12). Delaying harvest from

https://doi.org/10.23637/ERADOC-1-123

25 September to 4 November increased yield by about 3 tons/acre of roots, but further delay until 5 December increased it by only 0·7 tons/acre. Yields ranged from 13·7 tons/acre for late sowing and early harvest, to 21·6 tons/acre for early sowing and late harvest. Sugar as percent of dry matter decreased from 71·7% for the early sowing to 69·9% for the late, and was 4% less for the November harvest than for the September and December harvests; it was not affected by N. In contrast, N dressings increased α-amino N in the root juice, as did later sowing. Neither N nor harvest date consistently affected the Na and K content of the root juice but K content increased and Na decreased with later sowing.

TABLE 12

Sugar yields and per cent sugar of beet sown and harvested on different dates (mean of 4 N dressings)

	Lifting date							
Sowing date	September 25		November 4		December 5		Mean	
	cpa	%	cpa	%	cpa	%	cpa	%
13 March	54·8	14·8	65·8	15·7	66·8	15·5	62·5	15·3
8 April	45·8	14·8	58·1	15·5	58·8	15·6	54·3	15·3
24 April	40·0	14·6	49·8	15·4	56·5	15·8	48·7	15·3
Mean	46·9	14·8	57·9	15·5	60·7	15·6	55·2	15·3

Herbicides

Three herbicides, 'Murbetex', 'Betanal' and 'Pyramin' were tested at Broom's Barn, separately and in mixtures, by Mr. W. E. Bray of Norfolk Agricultural Station. Sugar yield averaged about 60 cwt/acre and was unaffected by herbicides, although the different mixtures differed in their ability to control weeds.

Trifluralin applied at 1 lb/acre a.i. on 28 May to the soil between the rows of sugar beet sown on 4 April on Brome Pin field and worked towards the plants distorted 10% of the roots by restricting their girth about 3 in. below the crown.

Hormone weedkillers. To estimate the effect of drift from spraying cereals, sugar beet were sprayed either 6 weeks after sowing with MCPA at 1/20 and 1/50 concentration recommended for killing weeds in cereals, or 11 weeks after sowing with MCPA, MCPB or CMPP at 1/20 and 1/50 and MCPA at 1/100 the recommended concentration. The 1/20 concentration spraying 6 weeks after drilling severely damaged the plants and the 1/50 concentration caused slight damage. Plants sprayed 11 weeks after drilling showed little effect. At harvest, plots sprayed with 1/20 concentration 6 weeks after drilling yielded 17% less than unsprayed plots. The other treatments did not significantly affect yield, although most slightly increased it. (Byford)

Cereal and rotation experiments

Fertilisers on rotation crops. This was the fourth year of the long-term experiment that tests fertilisers applied during a rotation of sugar beet,

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winter wheat and barley. (For the fertiliser dressings see *Rothamsted Report for 1965*, p. 279, Table 7.) All three crops gave a large response to N1 (Table 13), but only barley needed the N2 dressing. There was a small response by wheat and barley to P1 and to K1, and sugar beet responded to P2 and K2. Sodium greatly increased sugar yield, but where it was applied previously for sugar beet it decreased the cereal yields slightly; FYM increased sugar yield but had little effect on cereal yields. The large dressing of compound (C2) gave only slightly more yield than the usual (C1) dressing. (Draycott and Durrant)

TABLE 13

Yield responses of crops to fertiliser treatments in the fourth year of the rotation experiment

	Wheat grain (cwt/acre at 85% D.M.)	Barley grain (cwt/acre at 85% D.M.)	Sugar-beet sugar (cwt/acre)
Mean yield	23·0	24·9	49·3
Response to:			
N1	+9·9	+12·5	+7·0
N2–N1	−4·8	+5·6	−0·2
P1	+1·2	+1·8	+1·0
P2–P1	−1·8	+0·3	+1·9
K1	−0·2	+1·3	+5·6
K2–K1	−4·8	−1·2	+3·8
Na	−2·6	−1·4	+5·9
FYM	+1·1	−0·9	+8·2
Compound 1	+11·7	+10·6	+13·1
Compound 2–Compound 1	−3·8	+3·5	+2·6

Effect of previous cropping. This is the third trial to be completed at Broom's Barn testing how previous cropping and nitrogen manuring affect the yield and quality of sugar beet. The preparatory crops were grown on Brome Pin field in 1967 (for yields see *Rothamsted Report for 1967*, p. 286).

TABLE 14

Yields of sugar beet with different nitrogen dressings

Previous crops	N applied in 1967 (lb/acre)	N offtake in 1967 (lb/acre)	Yield of sugar (cwt/acre) in 1968 N dressing (cwt/acre) 0	0·5	1·0	1·5
Barley	56	73	60·1	69·6	72·4	74·1
Wheat	90	95	63·7	71·8	73·7	75·0
Potatoes	56	66	67·4	68·5	72·9	71·9
Potatoes	168	86	67·9	74·7	70·8	66·8
Ryegrass	56	65	51·1	65·1	75·1	64·9
Barley (undersown trefoil)	56	71	71·4	73·4	71·5	71·9

Table 14 shows that the amount of nitrogen fertiliser required for maximum sugar yield depended greatly on previous cropping and manuring; it was 1·5 cwt/acre after barley and wheat, 1·0 cwt/acre after potatoes given 56 lb N and ryegrass, and 0·5 cwt/acre after potatoes given 168 lb N and barley undersown with trefoil. The size of the response to N was also greatly affected by previous cropping; it was largest with ryegrass (14 cwt/

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acre) and smallest with barley undersown with trefoil (2 cwt/acre sugar). (Draycott)

Frequency of beet and barley. In this phased rotation experiment (*Rothamsted Report for 1967*, p. 290), beans yielded twice as much on plots where sugar beet had 150 units N in 1967 as where it received none. No residual effect of N was detected on potatoes following the beans.

Barley after beet, in a rotation of two barley crops and one beet, yielded 31·2 cwt/acre grain, 5 cwt more than barley after barley. In a rotation of five barley crops and one beet crop, the first barley after beet yielded 28·3 cwt/acre, the second 24·8, the third 21·4 and the fourth 21·1 cwt/acre of grain.

Crop rotations are affecting the yield of sugar beet in this fourth year of the experiment. Beet after three barley crops has yielded most sugar (average 64·2 cwt/acre), and after two barley crops next best (60·3 cwt/acre). Continuous beet (4 years) and the legume, potatoes, beet rotation both yielded 57·0 cwt/acre. The smallest yield (52·2 cwt/acre) was after two grass crops, although the potassium removed by the grass was replenished. The optimum dressing of N was 150 units/acre in the barley-beet rotations, and gave maximum yields of 69·1 and 70·7 cwt/acre; the optimum dressing in the other rotations was 100 units/acre N, which gave yields of 62·3 cwt/acre with continuous beet, 60·2 cwt/acre with beet/grass and 62·2 cwt/acre with beet/legumes/potatoes. (Hull)

Effect of residues from beet on barley. In 1967 sugar beet was grown in Flint Ridge field without N and with 50, 100 or 150 units N/acre; N increased roots from 15·7 to 17·6 tons/acre and tops from 7·3 to 11·2 tons/acre, but sugar yields negligibly. The nitrogen increased the amount of N in the tops from 0·48 to 1·06 cwt N/acre which then were either carted away or spread and ploughed in. In 1968, barley (Zephyr) was grown without N or with 33, 66 or 100 units N/acre; each amount was tested in all combinations with the N applied in 1967 and with or without ploughed-down sugar-beet tops.

Without N, barley yields were increased both by the residues of the N applied for the beet and by the ploughed-in tops (Table 15). Without tops, the N fertiliser residues increased yields by 2·9 cwt/acre of grain, with tops, by 4·3 cwt/acre of grain. When N was applied for the barley neither source of residual N increased yields; indeed, in five of six contrasts they decreased them. Mean yields were smaller than usual and the barley needed no more than 33 units N/acre. (Widdowson)

Nitrogen on barley. On the light sand at Herringswell where N leaches rapidly, three experiments tested different forms and times of giving N fertiliser. Where 0·60 cwt/acre N as 'Nitro-Chalk' was applied in the seedbed (12 March) the yield without a top-dressing was 26·7 cwt/acre grain at 85% dry matter; a top-dressing on 15 May of 0·80 cwt/acre N as 'Nitro-Chalk' gave 30·6 cwt/acre, the largest yield. Without N in the seedbed, the yield was 20·0 cwt/acre grain, and 1·20 cwt/acre N as 'Nitro-Chalk' was needed as a top-dressing (half given on 26 April and half on 15 May) for

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TABLE 15

Yields of barley after sugar beet

(cwt/acre of grain at 15% moisture content)

	N applied in 1968 (units/acre)				
	0	33	66	100	
N applied in 1967					
0	23·6	31·0	30·9	30·3	
50	26·3	30·2	31·0	30·0	±0·83 V ±0·77 HI
100	25·1	28·9	29·9	28·9	
150	27·2	30·3	31·7	28·7	
Tops removed in 1967	24·6	29·9	31·3	29·8	±0·59 V ±0·55 HI
Tops ploughed-in in 1967	26·5	30·4	30·4	29·1	

V = vertical. HI = Horizontal and Interaction comparisons.

the maximum yield of 29·6 cwt/acre. The experiment testing different forms of N was done in co-operation with Gasser, Chemistry Department. (Draycott and Webb).

Broom's Barn farm

The concrete to the west of the farm buildings was widened, a retaining wall built and appropriate alterations made to the underground services and drains in that area. An old land drain with D-shaped pipes was located after the heavy rain in September on the east side of Little Lane field. It was reconnected to the ditch and now runs freely.

Part of the farm to the south-west of the Windbreak was divided into three fields instead of two (map at end of Report). This gives five fields of 21–23 acres and five of 10–13 acres and each course of a five-course rotation is grown on a large and a small field. With this arrangement the area of each crop remains reasonably constant each year. The rotation is sugar beet, wheat or barley, wheat or barley, grass or beans, wheat.

Ploughing was completed by late January and crops were sown early in favourable spring weather. Hackthorn, the north half of New Piece and Windbreak fields were cultivated deeply during the summer, after crops had been removed, and Hackthorn and New Piece were levelled. Only the ley and the sugar-beet irrigation trials were watered. The north half of Marl Pit was limed. All ploughing was finished by the end of the year.

Cereals. In late February, 57 acres of barley were drilled using 1·5 cwt/acre of seed and 3·5 cwt/acre of 20–10–10 compound fertiliser. The barley in Dunholme was undersown with 14 lb/acre of Italian ryegrass and 6 lb/acre red clover. The Cappelle wheat sown in October 1967 was top dressed with 80 units/acre N in late March and the Maris Widgeon with 100 units/acre N on 3 May, as recommended by the millers to obtain a high protein content. The wheat on Little Lane, White Patch and Windbreak was sprayed with 'Actril C' on 26 April. Wheat on The Holt and barley on Marl Pit and Flint Ridge were sprayed with 'Banlene Plus' on 14 and 15 May. The undersown barley on Dunholme was sprayed with 'Legumex Extra' on 15 May. The wheat was laid by gales in July and the barley to a

https://doi.org/10.23637/ERADOC-1-123

less extent by wet weather in August. Harvest lasted from 20 August to 7 September. Moisture content of the grain ranged from 14% to 20%. Table 16 shows yields, acreages and varieties.

Winter wheat was drilled between 17 and 21 October on The Holt, Hackthorn, New Piece, east end of Windbreak and White Patch, and established quickly.

Beans. The south half of New Piece was drilled with 1·75 cwt/acre of Maris Bead tic beans and 2 cwt of a 0–20–20 compound fertiliser on 28 February. A week later the field was sprayed with 1·5 lb/acre of 'Gesatop' which controlled weeds well. The straw was spread with a forage harvester and ploughed in. A sample of beans won the Stanningfield and District Agricultural Club's Bean cup.

TABLE 16

1968 cereal and bean yields at 15% moisture

	Acres		Cwt/acre
Marl Pit	12·7	Sultan barley	35
Flint Ridge	21·8	Zephyr barley	32
Dunholme	22·1	Zephyr barley (undersown)	26
White Patch	22·6	Cappelle wheat	36
The Holt	11·0	Cappelle wheat	28
Little Lane	21·6	Maris Widgeon wheat	29
Windbreak	2·0	Cappelle wheat	33½
New Piece	5·5	Maris Bead beans	24¼

Fodder crops. The Italian ryegrass and clover mixtures received 3 cwt/acre of 20–10–10 compound on 6 March and a further 3 cwt/acre of 20–10–10 compound on 17 April. Silage making lasted from 20 May to 28 May. Both fields were immediately top dressed with 2 cwt/acre 21% N 'Nitro-Chalk' and 1½ in. of irrigation was applied. The new growth browned at the tips, which was attributed to infection by ryegrass and cocksfoot mosaic viruses thought to have been spread by the forage harvester. A crop of hay was taken in early July.

The new ley under the barley on Dunholme established very well during the wet summer.

Sugar beet. The basic fertiliser on Bullrush and the eastern third of Brome Pin was 6 cwt/acre kainit applied in the autumn and 6 cwt/acre of 20–10–10 compound on the seedbed. The remaining two-thirds of Brome Pin had 6 cwt/acre kainit in the autumn and 6 cwt/acre 21% N 'Nitro-Chalk' on the seedbed. Sowing started on 13 March and finished on 24 April. All the crop was sown with graded seed of which one quarter was monogerm and was band-sprayed with pyrazon. The uniform weed-free stand obtained was mainly thinned by hand. One spray with insecticide was given to control aphids and yellows. Lifting started on 24 September and continued through the autumn, sometimes on very wet land, to finish on 12 December. All undelivered roots were clamped on the loading platform. Yields averaged 16·2 tons/acre of clean roots at an average sugar content of 15·8%, ranging from 13·9% to 17·3%. Mean dirt and top tare was 12·1 lb/cwt. The country's average yield this year was 15¾ tons/acre

https://doi.org/10.23637/ERADOC-1-123

of roots at 15·3% sugar. A larger yield had been expected but harvesting losses were great in the wet conditions that persisted throughout the autumn and winter.

Livestock. During September and October 1967, 82 Hereford-cross steers were bought at an average live weight of 584 lb. All were fed in the yards with *ad lib* silage, hay and rolled barley up to 10 lb/head at the end of the fattening period. In the early stages a protein supplement and whole beans were added to the barley. The average liveweight gain was 1·5 lb/head/day and the average selling weight was 910 lb liveweight. All cattle were sold between 2 May and 26 June.

Fifty-nine Hereford-cross steers and 19 Hereford-cross heifers were bought in October 1968. (Golding)

Staff and visiting workers

P. C. Longden was appointed in June and D. Gray in November. G. D. Heathcote attended the 13th International Congress of Entomology in Moscow and R. Hull the International Institute of Sugar Beet Research Winter Congress in Brussels in February. The I.I.R.B. Journal Editorial Committee met at Broom's Barn in October. The numerous visitors included a group from the 1st International Plant Pathology Congress, one from the National Farmers' Union Headquarters Sugar-beet Committee and one from the Yorkshire branch committee. Symposia on Docking disorder and plant/soil moisture relations were attended by research workers from several institutes.

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