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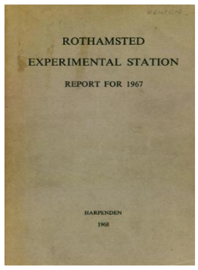

Broom's Barn Experimental Station

R. Hull

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BROOM'S BARN EXPERIMENTAL STATION

R. HULL

Yellows and aphids on sugar beet

A mild winter and early spring resulted in many sugar-beet crops being sown before the end of March. Mean temperatures during both February and March were 3·2° F above average, circumstances that in past years resulted in yellows becoming prevalent because crops were infested early with the vector *Myzus persicae*. April and May were cool and stormy, and although aphids dispersed from their winter hosts in the fine periods, populations on sugar beet were small. Hot, dry weather in June and July favoured their increase. Spray warnings were sent out by the sugar factories towards the end of May in the south-east and progressively later farther north. In some areas warnings were repeated because aphid infestations persisted, and *Aphis fabae* became prevalent in July. 307 000 acres of sugar beet were sprayed. Incidence of yellows at the end of August averaged 8·0% infected plants, estimated from the acreage infected to various degrees, and 5·3% on 113 sample fields. Mean incidence ranged from 23% in the Ipswich factory area to less than 1% in Yorkshire and Scotland.

Control by aphicides. Five trials in sugar-factory areas in eastern England and one at Broom's Barn compared the incidence of yellowing viruses in plots sprayed when a spray warning was sent to growers in the area, sprayed earlier or sprayed later. In addition, half of each plot was sown with seed treated with 4% by weight of menazon. The aphid population on the menazon-treated plots was only one-third of that on untreated plots when the spray warning was issued, and menazon increased yield by an average of 7 cwt/acre of sugar without further treatment.

Yellows spread widely only in the Felsted factory trial. At the end of September, on average, 37% of the untreated plants had yellows, and 23, 19 and 26% of the plants respectively in plots sprayed early, at the warning or late, but not treated with menazon. Menazon-treated plots averaged 26% yellows when unsprayed, and 21, 17 or 22% when sprayed early, at warning or late. This decrease of yellows by spraying did not increase yield additionally over menazon alone. The yield response to menazon was greater than would be expected from the effect on yellows. (Heathcote)

A trial at Broom's Barn (Flint Ridge field) tested a range of aphicides for control of green and black aphids, and virus yellows. Treatments were applied on 16 June when there were 13 wingless green aphids and 41 wingless black aphids/plant. The infestation increased steadily on unsprayed plots, to reach 69 green and 1684 black aphids/plant 18 days later. All the insecticides controlled aphids, decreased virus incidence on 18 August and most increased sugar yield (Table 1).

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TABLE 1

Effect of aphicides on aphids, yellows incidence and sugar yield, Broom's Barn 1967

Treatment (oz a.i./acre)	Aphid numbers as % of control (mean of 3, 7 and 18 day %'s) Apterous green	Apterous black	Yellows incidence 18 August (%)	Sugar yield 29 September (cwt/acre)
Sprays on foliage:				
Demeton-S-methyl (3·1)	1·1	0·8	11	51·2
Demeton-S-methyl + 2% oliocin emulsifiable spraying oil	1·1	0·7	15	42·6
Demephion (3·6)	0·9	0·8	10	54·7
Menazon (4)	16·6	22·2	21	50·3
Granules on foliage:				
Disulfoton (8·4)	7·6	4·7	19	51·2
Control	100	100	57	41·3

Menazon spray and disulfoton granules killed aphids slower but over a longer period than the other materials. Adding 2% oliocin emulsifiable spraying oil to demeton-S-methyl spray did not enhance its efficient control of aphids; this oil seemed not to damage the plants, yet sugar yield with it was significantly less than with demeton-S-methyl alone. Demephion is a new aphicide not yet approved for use on sugar beet. (Dunning and Winder)

Effect of yellows on yield. Plots of Sharpe's E and of the yellows-tolerant variety Maris Vanguard were again infected with BYV or BMYV on 6 June or 11 July, or kept as free as possible from infection by sprays. Infection later failed because the vector aphids were attacked by parasites. At the end of July most of the plants inoculated with BYV in June showed symptoms (Maris Vanguard 95% and Sharpe's E 99%), but fewer of those inoculated with BMYV did (27 and 32% respectively). The plots infected in July did not show this difference (77 and 89% with BYV and 65 and 77% with BMYV at the end of August). About 14% of plants on the plots not artificially inoculated had yellows at the end of September. These un-inoculated plots of Maris Vanguard yielded 58·8 cwt/acre, and of Sharpe's E, 57·3 cwt/acre sugar. Infection with BYV in early June decreased the yield of Sharpe's E to 43·7 cwt and to 52·0 cwt with BMYV, and that of Maris Vanguard to 48·2 and 51·8 respectively.

In a trial at Broom's Barn organised by the National Institute of Agricultural Botany, four experimental varieties were compared with Sharpe's E and the commercial, tolerant variety Maris Vanguard. The plots were sown on 17 March and harvested on 4 December by machine. Half the plots were infected with BYV and BMYV on 27 June by aphids, and the others protected from infection with insecticide sprays. On 22 August 97% of inoculated plants had yellows and 4% of the protected plants. Infection decreased the mean sugar yield from 54·2 to 43·3 cwt/acre. On the protected plots Sharpe's E yielded 56·8 cwt/acre, Maris Vanguard 55·0 and the other varieties from 52·5 to 54·7; on the inoculated plots Sharpe's E yielded 41·0 cwt/acre, Maris Vanguard 43·9 and the other varieties from

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41·5 to 46·1. On average Maris Vanguard yielded most. Infection with yellows decreased sugar percentage on average by 0·7, more with Sharpe's E (1·1) than Maris Vanguard (0·4). Maris Vanguard had 6·5% bolters, Sharpe's E 3·0% and the other varieties from 2 to 5%.

Mangold clamp and weed survey. Factory fieldmen again surveyed mangold clamps during late April; of 2028 farms in beet-growing areas, 681 (34%) grew mangolds. Nineteen per cent of 300 clamps were aphid-infested; 38 clamps lightly, 12 moderately and 8 heavily. Mangold acreage continues to decrease. Aphids from 18 samples of infested shoots were identified and tested for virus. Eleven clamps contained only *Rhopalosiphoninus staphyleae* and three only *Myzus persicae*. *M. ascalonicus* was in two clamps and *R. latysiphon* in one. None was shown to be carrying virus. Yellows became prevalent in mangolds in Kent in 1967, and infected mangold crops there may have provided the virus that spread late in 1966 to the sugar-beet seed crops in Kent.

Aphids occurred on 74% of the weeds collected by fieldmen in sheltered sites adjacent to mangold clamps or fields where beet was grown in 1966, twice the proportion during the equivalent period in 1966, and much more than the average (41%) for the previous eight years. Again, *M. ascalonicus* was the most frequent aphid (39% of the samples), but *M. persicae* was almost as frequent (37%) and more common than in 1966. *M. ornatus* was unusually common. BMYV was recovered from two samples of groundsel collected in the Felsted and Wissington areas. All other weed samples seemed virus-free.

Winged aphids. Approximately twice as many aphids were caught on each of seven sticky aphid traps as during 1966, but during August and September winged aphids were relatively scarce. Many *M. persicae* were trapped during May in south-east England. Many were also caught at Woburn during June and July, but not unusually many for this region. Five times as many *A. fabae* were caught during July 1967 as during July 1966, but afterwards the numbers caught decreased rapidly. A sticky trap in a beet-seed crop near Wisbech caught many fewer aphids than traps in beet-root crops elsewhere. (Heathcote)

Seed crops. Sixty per cent of samples of leaves and shoots from one-third of the 281 sugar-beet seed crops grown in England for harvest in 1967 examined from mid-May to mid-June had no aphids. The first sample with *A. fabae* came from Essex in the last week of May, and few samples were even moderately infested during the period of the survey. *M. persicae* overwintered on beet-seed crops in several areas, but only in Kent were the numbers large by the end of May. Some crops in Bedfordshire were heavily infested with *M. persicae* in June. Sugar-beet seed crops are usually freed from aphids by insecticides applied in the autumn, but occasionally, as this year, some aphids survive the winter on seed plants and multiply rapidly in the spring.

In June 1967 sugar-beet seed crops averaged 4·5% plants with virus yellows, the most since 1960. This was because of a few seed crops in Bedfordshire and Kent, where, as reported last year, aphids spread virus

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to stecklings in September. In Bedfordshire nine seed crops averaged 11·8% of plants with yellows, and nine crops in Kent averaged 17·8%. Elsewhere few plants had yellows. Only five mangold seed crops were inspected, and none had more than 2% of plants with yellows. In October no steckling bed had as many as 1% of infected plants, and the mean incidence in 120 beds was 0·05%. (Byford and Heathcote)

Effect of cultural factors on aphid populations. Plots of Sharpe's E sown on 13 March, 4 April or 27 April were singled to give average plant populations of 48·6, 26·6 or 16·0 thousands/acre. As in previous years the numbers of green and black aphids per plant were inversely proportional to the plant population, but although the numbers of *M. persicae* were more or less constant per unit area, *A. fabae* were most abundant on plots with the medium plant population. There were more *M. persicae* on the later than earlier sown plots, but in contrast with previous results *A. fabae* were most numerous on the earliest sown plots. The percentage of plants with yellows was again inversely proportional to the plant population, and the number of infected plants/unit area was also inversely proportional to the plant population (approximately 3700, 4800 and 6600/acre with decreasing plant population). Yellows was most prevalent in the plots sown on 27 April.

Another trial, drilled on 15 March with an even greater range of plant populations (7900–68400 plants/acre), but sprayed with an aphicide also had fewer aphids per plant with increase in plant number. Before the plots were sprayed *A. fabae* and *M. persicae* were more numerous on plots given a large dressing of N than on those without N fertiliser, but yellows incidence was similar. Half the plots had 5½ in. irrigation water during the season; 49% more plants on the irrigated plots had yellows than on the non-irrigated plots.

Cover crops on stecklings. Sugar beet were sown in rows 20 in. apart on 4 April. Some plots were left without cover, others were sown the next day with two rows of barley or mustard between each pair of beet rows or had strips of aluminium foil 2½ in. wide laid between the beet rows. On 16 June the narrow strips were replaced by strips 10 in. wide.

TABLE 2

Aphids and yellows incidence on sugar beet under cover crops

	Aphids/plant 21 June		% plants with yellows
	M. persicae	*A. fabae*	(30 September)
Barley cover	0·09	0·19	0·9
Mustard cover	0·02	0·49	0
Metal strip	0·51	2·06	6·0
Open beds	2·40	29·86	7·4

The unprotected beds were infested with numerous black aphids in late June, but numbers rapidly decreased and by the end of July the stecklings were almost free. Table 2 gives the numbers at the peak of infestation, and the yellows incidence at the end of September. In 1967 the metal strip decreased the aphid infestation more than in 1966, although the wider strip

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was used too late to have maximum effect. Cover crops decreased yellows incidence, but the metal strip did not. (Heathcote)

Seedling pests

Co-operative work testing various metaldehyde treatments to control slugs is described in the report of the Entomology Department (p. 200).

Defoliation. Plants in a crop sown on 4 April were defoliated once at different dates from May to September inclusive to measure effects on yields. Sugar yields at harvest on 15 November were: untreated 68·5 cwt/acre, 11 May defoliation 59·2 (13·5% decrease); 12 June 57·7 (15·8%); 10 July 49·0 (28·5%); 14 August 42·0 (38·6%) and 20 September 47·4 (30·7% decrease). These decreases were mainly attributable to smaller roots, especially of plants defoliated in July and August, but sugar content was also less in those defoliated in August, and much less in those defoliated in September. Top and crown yield declined progressively from 9·2 ton/acre on the untreated plots to only 4·6 ton/acre on those defoliated on 20 September. (Dunning and Winder)

Seed treatment

Pesticides in pelleted seed. Twenty-one trials in different areas tested various fungicides and insecticides incorporated experimentally during pelleting of Sharpe's E seed by the Germain process. Analysis of the insecticide content of the pellets by the British Sugar Corporation's Research laboratory showed that the required doses were more nearly achieved in these experimental pellets than when previously dusted seed was made into commercial pellets; they contained 95–116%, mean 103%, of the intended doses of the materials used. Distribution on individual pellets was more uniform when the pesticides were incorporated in the outer than in the inner layers of pelleting material.

Seedling emergence and plant establishment was slightly improved only by the usual rate of γ-BHC (480 ppm of pelleted seed). The usual and quarter usual rates of dieldrin (544 and 166 ppm), thionazin (1478 ppm) and Murphy's N 2790 (385 ppm) had no effect. (Dunning and Winder)

Fungicide. Trials at 18 centres compared an organo-mercury dust applied either in the inner or the outer layers of the pelleting material with seed steeped in EMP before pelleting. The seed was heavily infected with *Phoma betae*. The dusted seed gave 42·3% more seedlings, and 21·9% more plants in the final stand, than untreated seed, and the EMP steep gave 97·3% and 42·5% more. The differences between fungicide dust applied in the inner or the outer layers of the pellet were small.

In a small field trial, EMP steep gave 117% and maneb (14·5 oz/cwt of an 80% dust) 114% more seedlings than untreated seed, whereas an organo-mercury dust gave 94%, thiram steep 79%, difolotan dust 61%, difolotan slurry 58% and a copper-based slurry 33% more seedlings than untreated seed. (Byford)

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Leaf diseases

Downy mildew. Incidence of downy mildew in steckling beds in 1966 averaged 0·07%, but the mild winter favoured its spread and some seed crops in south Lincolnshire had between 20 and 30% of plants infected in June 1967. Moderate attacks were recorded in other areas, but the average of 2·4% plants infected was less than in 1965 or 1966. The disease spread to many root crops in the seed-growing areas, particularly in south Lincolnshire, and to a lesser extent in Essex, but elsewhere was not severe.

For the third year the relative resistance of varieties of sugar beet to downy mildew were 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 in different varieties from 20 to 60%. The commercial varieties with fewest infected plants were Amono, Anglo-Maribo Poly, Zwaanpoly and Sharpe's Klein E; those with most were Hilleshog N, Bush Mono, Maris Vanguard, Hilleshog E and K. W. Erta; the differences between varieties agreed well with results in 1966. A count in late July gave the same relationship between varieties as the total of plants infected during the season. Plants infected at different times were harvested in October from the ten varieties with most infection, and all conformed to the typical yield loss pattern, with the loss in root weight most with plants infected during June, and the loss in sugar content most with plants infected during July.

Single rows of three varieties were sown at 22 sites in root crops situated near seed crops in south Lincolnshire, west Norfolk and Cambridgeshire. In July and August Hilleshog N averaged 12·3% of plants infected, Sharpe's Klein E 5·9% and Sharpe's Klein Poly 7·9%, which parallels the relative infections in these three varieties at Trawscoed.

A trial at Broom's Barn in a crop in 20-in. rows, singled to give 37000 plants/acre, tested the ability of surviving plants to compensate in yield for loss of plants occurring after singling. When alternate plants were removed in the first week of June sugar yield was decreased by 5%, and by 7% when alternate pairs of plants were removed. The corresponding yield decreases when plants were removed in the first week of July were 21 and 26%, and in the first week of August, 38 and 40%.

***Ramularia* leaf spot.** This disease was widespread in the autumn of 1966 in steckling beds in Oxfordshire, Kent and south Lincolnshire, but not in Bedfordshire. It persisted through the winter, but was less evident while the crop was growing vigorously in spring and early summer. It became prevalent again in seed crops in July, and by August had defoliated many crops. Defoliation was fastest in open, direct-drilled crops in Kent and Oxfordshire, but it also occurred on some crops that had been direct-drilled under cereal cover crops in south Lincolnshire. *Ramularia* occurred in open direct-drilled seed crops in Bedfordshire, but did not defoliate them.

Two trials in open direct-drilled seed crops at Brenzett in Kent tested fungicides to control *Ramularia*. Plants sprayed three times between mid-

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March and late May with fentin hydroxide at 0·6 lb a.i./acre or maneb at 12 lb a.i./acre had few *Ramularia* spots in early July, when unsprayed plants had many and lower leaves were already killed. Thiabendazole at 1·5 lb a.i./acre gave moderate control of *Ramularia*, but was less effective at 0·9 lb a.i./acre; maneb at 2·4 lb a.i./acre had little effect. Five sprays with maneb at 2·4 lb/acre controlled *Ramularia* less well than three sprays with fentin hydroxide at 0·6 lb/acre. By August the disease was evenly distributed through both sprayed and unsprayed plots, and at harvest in late August sprayed and unsprayed plots yielded equally. (Byford)

Docking disorder

Survey. More sugar beet was affected by Docking disorder than ever before, and it occurred in several areas where it had not previously been recognised, although its incidence was restricted to light, sandy soils. The heavy rain in May not only leached essential nutrients from the soil but also provided ideal conditions for nematodes to be active; probably these factors were responsible for the widespread damage early in the season.

About half of the soil samples taken by fieldmen from more than 100 fields with affected sugar beet contained enough nematodes to cause the damage. *Trichodorus* was associated with root stunting in Yorkshire and North Lincolnshire, *Longidorus* in the Allscott factory area and both nematodes were numerous in soils from East Anglia. About 6000 acres of beet were affected by the end of June; the worst-hit areas were King's Lynn (1600 acres), York (1481 acres), Selby (830 acres) and Bury St. Edmunds (789 acres).

Many crops apparently recovered during the dry summer, but despite the better top growth, the roots were fangy and yielded poorly. (Cooke)

Viruses. Few reports were received in 1967 of the virus diseases associated with Docking disorder, but the list of sites at which tobacco rattle virus ("yellow blotch" of sugar beet) occurs grows steadily. The presence of the virus was confirmed at new sites in Suffolk and Norfolk, and in the Easingwold district of Yorkshire. A virus with spherical particles (probably tomato blackring) was found in a beet-seed crop in Bedfordshire. (Heathcote)

Herringswell Rotation Experiment. This was the second year of the trial testing the effect of crop rotation, soil fumigation and nitrogen dressing on crop yield and nematode numbers.

Nematodes. Half of the 32 sub-plots cropped with sugar beet in 1967 were fumigated in December 1966 with 33·5 gal/acre of dichloropropane–dichloropropene ("D-D"). Other plots had been similarly fumigated before the 1966 crop. The numbers of *Longidorus*/litre of soil at two sampling dates from eight sub-plots were:

		7 March	25 August
Fumigated 1965	Fumigated 1966	1	0
Fumigated 1965	Not fumigated 1966	4	6
Not fumigated 1965	Fumigated 1966	3	3
Not fumigated 1965	Not fumigated 1966	351	68

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This year's ryegrass, wheat, barley and potato plots were not fumigated, and *Longidorus* populations increased in the sub-plots fumigated in 1965 from 3·7% in March to 6·7% in August of those in the unfumigated sub-plots. Cropping affected *Longidorus* numbers in unfumigated sub-plots as in 1966, except that numbers in the ryegrass plots decreased (Table 3).

TABLE 3

Effect of 1967 crops on Longidorus *at Herringswell*

1967 crop	Number of plots sampled	*Longidorus*/litre soil March	August
Sugar beet	8	351	68
Barley	8	145	103
Wheat	2	155	135
Potato	4	170	313
Ryegrass	2	280	170

Of the other plant parasitic nematodes, *Tylenchorhynchus* was the most abundant, especially under ryegrass, where there were 6000/litre, under cereals there were 1700/litre and under sugar beet and potatoes only 700/litre. In the sub-plots fumigated in 1965 populations increased from 37% in March to 42% in August of numbers in the unfumigated sub-plots. *Pratylenchus* were about 1300/litre under all crops. Numbers in the sub-plots fumigated in 1965 increased from 16% to 41% of those in the unfumigated sub-plots. Other plant parasitic nematodes were less numerous, although the ryegrass plots supported *Trichodorus* (300/litre) and *Hemicycliophora* (500/litre) populations.

Soil nitrogen status. Similar nitrogen determinations to those reported last year (*Rothamsted Report* for 1966, p. 283) investigated the part played by nitrogen in crop responses to "D-D" (Table 4).

TABLE 4

Ammonium and nitrate nitrogen in soil in May 1967 at Herringswell

	Sampling depth 0–4½ in.	4½–9 in.	9–24 in.
	lb/acre-in.		
Fumigated in 1965	5·3	1·3	3·3
Fumigated in 1966	8·3	5·3	5·0
Fumigated in 1965 and 1966	4·3	2·3	1·3
Unfumigated	1·3	1·3	1·3

The small nitrogen content of the unfumigated soil indicates that there was more leaching in 1967 than in 1966. All the fumigation treatments increased the amount of mineral nitrogen in the soil, especially in the top 4½ in., partly because of increased mineralisation and partly because nitrification is slowed. Clearly these effects last for more than 1 year even when, as in 1967, nitrogen was leached by heavy rain in the spring.

Soil moisture. The moisture status of the soil was measured each fortnight by neutron moderation to a depth of 4 ft in plots of sugar beet, potatoes, grass and barley. Sugar beet extracted much moisture from the whole profile to more than 4 ft deep by mid-July, whereas potatoes ex-

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tracted moisture only from the upper 3 ft. This suggests a considerable difference in the rooting depth of the two crops and explains why sugar beet yielded well and potatoes did not in this relatively dry summer.

Yields. Fumigation in December 1966 increased sugar yield of beet in the previously unfumigated plots, but decreased it in plots fumigated in 1965 (Table 5). The plots fumigated in 1965 only yielded better than those fumigated in 1966 only, despite the extra mineral nitrogen in the latter. "D-D" damaged the beet, even when applied 3 months before drilling; soil analyses indicated that this may be because fumigation inhibited nitrification of ammonium nitrogen.

TABLE 5

Yields from sugar beet in 1967 after fumigation at different times
(cwt sugar/acre)

	Not fumigated	Fumigated 1966
Not fumigated 1965, no extra N	56·70	63·18
Fumigated 1965, no extra N	70·13	63·45
Not fumigated 1965, extra N	60·35	68·00
Fumigated 1965, extra N	69·03	60·98

Ryegrass yields were decreased by fumigation in 1965, because so much nutrient, especially potash, was removed in the large crops the fumigated plots produced in 1966 (Table 6). Cereals yielded more than in 1966 and still benefited from the 1965 fumigation, as also did potatoes. (Cooke and Draycott)

TABLE 6

Yields of dry matter (cwt/acre) from rotation crops at Herringswell, 1967

	Not fumigated	Fumigated	Not fumigated	Fumigated
	1965		1965	
Crop	No extra N	No extra N	Extra N	Extra N
Barley grain	23·0	26·7	25·8	29·3
Barley straw	31·3	37·0	32·7	35·6
Wheat grain	29·2	33·1	32·1	35·1
Wheat straw	35·1	39·3	34·5	37·5
Potatoes (tubers)	43·0	61·0	41·0	58·4
Ryegrass	56·1	50·3	57·9	47·5

Seed spacing. A trial at Herringswell, Suffolk, tested the effect of seed spacing on numbers of *Longidorus* around individual sugar-beet plants and

TABLE 7

Numbers of Longidorus *in soil around sugar beet at different spacings, Herringswell, 1967*

Seedling spacing 30 May (in.)	*Longidorus* number/litre soil		Plant spacing 1 December (in.)	Yield of sugar (cwt/acre)
	30 May	20 October		
6·1	296	55	14·2	60·5
2·5	286	67	11·2	64·4
1·4	198	34	10·4	66·5
0·4	180	31	9·5	60·5

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on final yield. Soil samples taken in May, consisting of several 1-in.-diameter cores with a seedling in the centre of the core, had more *Longidorus* round the plants at the wider spacings; this was still just apparent in October when the cores were taken down the side of the beet (Table 7). This difference is attributed to the larger volume of soil from which nematodes can be attracted around the wider-spaced plants. Yields were large and not related to the numbers of *Longidorus*; the crop did not develop Docking disorder. (Cooke)

Nitrogen top-dressing experiments. Two experiments in East Anglia where beet was severely affected by Docking disorder in May tested top dressings supplying 0, 0·5 and 1·0 cwt/acre of N applied in early June. The crops had received the farmer's usual dressing of fertiliser in the seed-bed. The average yields of sugar were small, about 40 cwt/acre, although the crops made vigorous leaf growth and seemed to have recovered. The top-dressing of nitrogen did not improve the sugar yield at either site, confirming results of previous experiments (*Rothamsted Reports* for 1965, p. 267, and 1966, p. 286). In contrast, crops with Docking disorder responded to more than recommended dressings of N in the seed-bed, as described in the next section. (Draycott and Last)

Nitrogen and fumigation. Four experiments on fields where nematodes were numerous and Docking disorder was probable in Brigg, Cantley, King's Lynn and York factory areas tested the effects of soil fumigation and N fertiliser as "Nitro-Chalk" on sugar-beet yields. An experiment near Bury St. Edmunds was on similar soil, but with fewer than 40 *Longidorus*/litre of soil. No Docking disorder occurred on this site, but the crops were affected on the other four sites, where *Trichodorus* populations were large.

Soil samples taken in April from the four *Trichodorus* sites showed nematodes to be most abundant in the 4–6-in. and 6–8-in. layers (up to 3000 *Trichodorus*/litre), and fewest (600/litre) in the surface 2 in. Fumigation with 33·5 gal/acre of "D-D" killed more than 90% of the *Trichodorus*. By May fumigated plots on all the affected sites grew larger plants, and at the York site seedlings in unfumigated plots had blackened stubby lateral roots typical of *Trichodorus* damage. Soil samples taken in August showed that *Trichodorus* had declined to about half the April number in all depth fractions. The fumigated plots contained an eighth as many as the unfumigated plots. At harvest tap roots were fangy on the unfumigated plots at all four sites. Root shape was improved slightly by large amounts of seed-bed N, and considerably by fumigation.

Table 8 shows that the sugar yield was greatly increased by "D-D" and less by N. Without "D-D" more than 2·0 cwt/acre N was needed for maximum yield, but with "D-D" only 0·66 cwt/acre N. At Bury St. Edmunds "D-D" gave only a small response; 1·0 cwt/acre N was needed for maximum sugar yield and gave the usual response.

Thus, in soils with enough nematodes to cause Docking disorder yield is increased by larger dressings of fertiliser N than otherwise needed, presumably because the damaged roots are less able to explore the soil. Soil

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fumigation with "D-D" improves rooting and decreases the need for applied N. (Draycott and Cooke)

TABLE 8

Mean effect of nitrogen and fumigation with "D-D" on sugar yield at four sites affected by Docking disorder, 1967

(Sugar yield (cwt/acre))

Nitrogen dressing (cwt/acre)	0	0·66	1·32	1·98
Not fumigated	30·0	32·9	35·7	40·0
Fumigated with "D–D"	49·7	60·1	55·1	57·4

Nematicide trials. Trials at Thornton near York, and Hellesdon near Norwich, tested a range of materials applied as seed-dressings to raw seed, or incorporated in the coating of pelleted seed, or applied as liquids or granules in the furrow with the seed. At Thornton the trials were in the same field as in 1966 (see *Rothamsted Report* for 1966, pp. 284–286), but followed a barley crop undersown with ryegrass and clover. When the seed was sown on 10–12 April there were 6000 *Trichodorus*/litre of soil to 8 in. depth, considerably more than in 1966. The site had been ploughed in December and 6 cwt/acre of 20 : 10 : 10 fertiliser and 4 cwt/acre salt applied in late February. "Pyramin" herbicide was sprayed over all the trial immediately after drilling. At Hellesdon on 23 March there were 2000 *Trichodorus*/litre of soil to 8 in. depth. The field had been ploughed in the winter and 120 units N with P and K applied early in March. "Pyramin" was applied in a band over the rows during drilling.

At Thornton one trial compared "D-D" fumigation (210 lb/acre injected by hand at 12-in. centres, 6 in. deep, on 17 January), menazon seed-dressing (3 oz a.i./acre), thionazin seed-dressing (0·4 oz a.i./acre incorporated in the coat of pelleted seed) and thionazin granules (13·5 oz a.i./acre in the furrow with the seed), all sown with Sharpe's E seed at 2 in. spacing ($4\frac{1}{2}$ lb/acre) on 10 April; variety Triplex M, which is noted for seedling vigour, was also tested. Thionazin granules seriously decreased seedling emergence and stunted early growth, a result contrary to that in 1966 at the same site with the same dose. No treatment increased seedling numbers, but "D-D" greatly increased seedling vigour. "D-D", thionazin granules and thionazin in the seed-pellets gave seedlings with root systems much less damaged by nematodes than with the other treatments. A "Nitro-Chalk" top-dressing (30 units N) was given to half each plot on 31 May and again on 4 July. Plant population was decreased by thionazin granules, but this treatment, and especially "D-D", increased plant vigour during the summer, as did the extra nitrogen. On 18 October plots treated with thionazin granules yielded fewest harvestable roots; with all nematicides additional N tended to increase the number of harvestable and of fangy roots, and considerably increased top yield. Sugar yield (27 cwt/acre on the control) was increased by thionazin in the seed pellet (32 cwt), thionazin granules (34 cwt) and especially by "D-D" (53 cwt); all these yields were increased by nitrogen top-dressing (33, 44, 38 and 57 cwt sugar respectively). Triplex M seed yielded only 21 cwt sugar, but 36 cwt with additional nitrogen; the nitrogen top-dressing response at this site may have been because the basal dressing was applied too early.

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At Hellesdon one trial included some of these treatments, viz. menazon seed-dressing (3·0 oz a.i./acre), thionazin seed-dressing incorporated in the coat of pelleted seed (0·5), and thionazin granules at two rates (4·8 and 17·4) in the furrow with the seed, all sown with Sharpe's E seed at 2 in. spacing (5 lb/acre) on 23 March. As at Thornton the larger amount of thionazin granules decreased seedling emergence, vigour and the final population. Half of each plot was top-dressed with "Nitro-Chalk" (50 units/acre N) on 14 June. At harvest on 26 October N top-dressing did not significantly increase either numbers of harvestable roots or sugar yield, but increased top yield; of the treatments applied at drilling, only thionazin incorporated in the pelleting material increased sugar yield.

At Thornton 11 materials and at Hellesdon seven were tested in various formulations, using single row plots. Treatments at Thornton (and amounts of active ingredient in oz/acre—24-in. rows) were: seed-dressings —menazon (2·8), thionazin (3·7, 0·7 and 0·1) and carbamate J.F. 2268 (1·1); incorporated in pellets—thionazin (0·4) and N 2790 (0·1); granules in the furrow with the seed—thionazin (8·5, 13·0 and 31·9), "Temik-U.C. 21149", (4·2, 6·6 and 15·6), menazon (13·5) and phorate (9·1); water solutions or suspensions in the furrow with the seed at approximately 13 gal/acre—thionazin (4, 13 and 40), "Lannate—Dupont 1179" (4, 13 and 40), "Dupont 1642" (4, 13 and 40), "Berks GC 5940" (coco-1,3-propylene-diamine, 13 and 40) and the Philip's-Duphar chloropyridins PH 80-16 and 80-17 (both at 13 and 40 oz a.i./acre). Seedling and, later, plant numbers were decreased by the largest amounts of thionazin seed-dressing, all amounts of thionazin granules, the largest and medium amount of thionazin and "Lannate" solutions and the largest amount of "Dupont 1642" solutions; most of them made roots less fangy, but, except for thionazin granules and the medium amount of "Lannate" solutions, these treatments did not increase sugar yield. Pelleting the seed improved sugar yield but not root shape, and incorporating thionazin in the pelleting material improved sugar yield still further (29 to 37 to 43 cwt respectively). Similarly, the two chloropyridins and "GC 5940" increased sugar yield slightly, especially with the larger amounts, but did not improve root shape. All other treatments, and especially "Temik", increased sugar yield (Table 9). Root fanginess was decreased by phorate granules, thionazin granules (32 oz) and solution (48 oz), "Lannate" solution and especially by "Temik" granules.

"Temik" granules, especially the largest amount, decreased numbers of *Trichodorus* in the root zone in June and October; the effect of other treatments on nematode numbers was not determined.

Treatments in the similar trial at Hellesdon (and amounts of active ingredients in oz/acre—20-in. rows) were: seed dressings—menazon (2·8) and thionazin (3·5, 0·7 and 0·1); incorporated in pellets—thionazin (0·5) and N 2790 (0·1); granules in the furrow with the seed—thionazin (4·8) 9·5 and 17·4), "Temik" (2·4, 4·7 and 6·9) and phorate (5·1); water solutions or suspensions in the furrow with the seed at approximately 16 gal/acre—thionazin, "Lannate" and "GC 5940" (each at 5·3, 16 and 48). As at York, seedling numbers were decreased by the largest amount of thionazin seed-dressing, all amounts of thionazin granules and solution,

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the largest amounts of "Lannate" solution and phorate granules; plant numbers were decreased only by the largest amount of thionazin seed-dressing and by granules, and the larger amounts of thionazin solution. During June and July rows treated with "Temik" granules and with the smaller amounts of "Lannate" solution were consistently more vigorous than the untreated rows. Table 9 shows how some of these treatments affected yield and root fanginess.

TABLE 9

The effect of nematicide treatments at drilling on sugar yield and root fanginess

(See text for other treatment effects)

Treatments	Thornton, York oz a.i./acre	Thornton, York Root fanginess (0–5 scale)	Thornton, York Sugar yield (cwt/acre)	Hellesdon, Norwich oz a.i. acre	Hellesdon, Norwich Root fanginess (0–5 scale)	Hellesdon, Norwich Sugar yield (cwt/acre)
Control	—	3·1	29·2	—	1·8	48·5
Seed dressing:						
Thionazin	0·7	3·2	38·7*	0·7	1·3	46·8
Thionazin	0·1	3·2	35·8	0·1	2·1	54·0
Granules:						
Thionazin	32	2·5**	31·4	17	1·5	51·1
Thionazin	13	2·9	44·5***	9	1·4	51·9
Thionazin	9	2·9	45·8***	5	1·7	54·1
"Temik"	16	0·7***	62·2***	7	0·7***	80·2***
"Temik"	7	0·8***	53·7***	5	0·5***	77·4***
"Temik"	4	1·0***	55·8***	2	0·5***	76·9***
Phorate	9	2·4**	42·6**	5	2·1	48·4
Solution:						
"Lannate"	40	2·1***	21·6	48	1·2**	64·2*
"Lannate"	13	2·0***	38·5*	16	0·7***	71·9
"Lannate"	4	2·6*	40·4*	5	0·4***	70·4

*, ** or *** significantly different from the control at 5%, 1% or 0·1% levels of probability.

In co-operation with the British Sugar Corporation two varieties of beet and two depths of drilling seed were tested factorially, with and without menazon seed-dressing, at 15 sites where Docking disorder was expected. Three sites had to be discarded because of wind erosion, and Docking disorder was obvious at only three of the remaining sites. *Trichodorus* were numerous at these and one other site at harvest. There was no consistent difference between treatments, either at emergence or during the growing season, and yields were unchanged by any treatment combination.

At three sites where Docking disorder occurred and nematodes were numerous in the root zone of stunted plants nematicide solutions were injected around the plants. Sites, approximate numbers of nematodes/litre of soil and dates of treatment were: East Wretham, Norfolk, 100 *Longidorus* and 100 *Trichodorus* on 7 June; Raskelf, York, 750 *Trichodorus* on 12 June; and Herringswell, Suffolk, 900 *Longidorus* on 20 June. The solutions were injected at both sides of the plant, using 40 ml/plant, equivalent to 220 gal/acre. Ammonium sulphate to give 50 units/acre N was compared with the following materials at 4 lb and 1 lb active ingredient/acre: "Dupont 1642", "GC 5940", "Lannate", the chloropyridins PH 80-16

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and PH 80-17, "Temik" (extracted from granules with methanol and water) and thionazin; not all these materials were tested at all three sites. At Raskelf nitrogen improved top growth, and root yield by 54%; no other treatment, and at other sites no treatment, improved root yield.

At Herringswell in August three nematicidal materials were applied, in the furrow with the seed, in various amounts to determine their relative phytotoxicity; the smallest amounts that obviously damaged seedling growth were—"Lannate" solution 32 oz a.i./acre, "Lannate" granules >32 oz, "Temik" granules 46 oz and thionazin granules 7·5 oz.

Summarising the results of nematicide trials on Docking disorder sites over the last 3 years, no chemical applied into the soil around stunted plants in May or June cured the condition, but some chemicals applied with the seed at the time of drilling in March or April ensured less fangy roots, more vigorous growth and greater yield. Much nitrogen, as used in the 1967 trials, seems essential to give the greatest yield. Phorate and thionazin often increased yield, but they damaged seedlings; "Temik" did not, and very small amounts/acre increased yield greatly in 1967. Materials of this type offer a practical method of increasing sugar-beet yields on light, sandy soils where free-living nematodes are prevalent. (Dunning and Winder)

Sugar-beet seed crops

For the third year, experiments at Preston Capes, Northants., at Chipping Norton and Bloxham, Oxon., at Sutton St. James, Lincs., and Great Gransden and Great Staughton, Bedfordshire, tested various cultural practices of seed growing. Harvest was 10 days earlier than in 1966 and 3 weeks earlier than in 1965.

Method of growing. Four methods of growing monogerm seed were compared at Great Gransden; spring-sown under early or late-maturing varieties of barley; sown in June, July or August without a cover crop; transplanted in autumn from June and July sowings; and transplanted in spring from the July sowing. This experiment gave a better stand of beet under barley than the previous one at Silsoe, and after the winter the plants were comparable to those drilled in July. The autumn transplants survived the winter well, but in April pigeons severely damaged the fresh growth. Plant density of open drilled plots was less than at Silsoe, and drilling in August produced a thin stand. Downy mildew infected all plots, particularly those drilled in the open during June and August. Virus yellows did not occur until the second year, when there were a few infected plants in some plots with thin stands. By May of the second year the total haulm and root yields were greatest from the June-drilled plants and were four times as much as from those drilled in August, the smallest plants. Plots drilled in June bolted and ripened earliest, followed by the July sown and undersown plots. As in other years, transplants matured later than other treatments. Plots of each treatment were harvested when ripe. The July sowing yielded most seed, the autumn transplants least and the other treatments gave similar, intermediate, yields (Table 10).

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Germination percentages were greatest from early ripening June-drilled and undersown plots, and least from late-ripening August-drilled and from stecklings transplanted in autumn from plots drilled in July. In both years August sowing gave small seed, mostly monogerm.

TABLE 10

The effects of methods of growing on yield of clean beet seed and other features

Cover crop removed		Sown without cover			Sown in June and transplanted in	Sown in July and transplanted in	Sown in July and transplanted in
Early	Late	June	July	August	October	October	February
Yields of clean seed (cwt/acre) (±1·57)							
22·2	24·9	25·0	29·0	23·6	21·4	20·3	23·1
No. of clusters/lb (± 1890)							
34 100	37 250	34 800	38 000	44 900	40 780	42 550	39 160
Germination percentage							
66·3	66·0	78·3	62·8	58·3	62·7	56·3	62·7
Monogermity (%)							
90·3	87·4	93·6	92·4	95·9	94·8	96·0	92·1

Also at Great Gransden stecklings of the same monogerm variety were sown on 3 June, 18 July and 14 August; they weighed on average 146·0, 39·7 and 1·25 g and were 43·4, 26·2 and 7·8 mm diameter at the crown in the following spring. They were transplanted at 20 × 20 in. spacing in early March. Only half of the small stecklings survived until harvest, and they flowered and ripened late. Yields of clean seed from large, medium and small stecklings were 23·0, 20·9 and 9·2 cwt/acre, and seed weight and germination percentage increased with steckling size.

Time of sowing and harvest. At Chipping Norton stecklings were sown on 7 July, 27 July and 15 August. Plants from the third sowing grew slowly, and weeds infested the plots, but herbicide sprays checked them. As in 1966, downy mildew was progressively more prevalent and *Ramularia* less prevalent with later sowing. The late-sown plants ripened late. The plots were harvested on 25 August, 30 August and 5 September (Table 11).

TABLE 11

The effect of sowing and harvesting date on yield of clean seed (cwt/acre) at Chipping Norton, 1967

Sowing date	Harvest date: 25 August	30 August	5 September	Mean (±0·54)
7 July	17·1	18·5	13·0	16·2
27 July	16·8	13·5	9·3	13·2
15 August	14·9	16·9	12·5	14·8
Mean (±0·61)	16·3	16·3	11·6	

On 25 August yields from July sowings were greater than from August sowing, but the middle sowing then lost seed rapidly and was the smallest yielder at later harvests. As in previous experiments, earlier sowing and later harvesting gave larger seed with greater germination percentages.

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Fertiliser in the second year. Three dressings of ammonium sulphate giving 0·5, 1·0 and 1·5 cwt/acre of N were applied in spring to four plant populations derived from the factorial combinations of 10-in. and 20-in. rows and 2-in. and 9-in. spacing in the row. The crop had received 0·85 cwt/acre N, 0·85 cwt/acre P_2O_5 and 1·25 cwt/acre K_2O in the first year. There was no interaction between nitrogen and plant population, and the yields from the three N dressings were respectively 20·0, 20·8 and 19·6 cwt/acre ($\pm$0·60). Seed was progressively smaller with more nitrogen.

Experiments at Preston Capes and Sutton St. James tested five nitrogen dressings in the spring giving 0·5, 1·0, 1·5, 2·0 and 2·5 cwt/acre of N. At Preston Capes the crop was sown in summer without cover and received 0·3 cwt/acre N, 0·75 cwt/acre P_2O_5 and 0·75 cwt/acre K_2O. The mean yields from the five N dressings were respectively 27·6, 28·6, 33·4, 31·4, 31·8 cwt/acre ($\pm$1·30). Additional phosphate and potash in the second year did not affect seed yield. At Preston Capes in 1965 plots with most nitrogen gave smaller seed with smaller germination percentage; there was the same trend in 1967, but differences were not significant.

Stecklings were undersown in barley in deep, fertile, silty clay loam at Sutton St. James and received 0·7 cwt/acre N, 1·05 cwt/acre P_2O_5 and 0·7 cwt/acre K_2O in the autumn. Mean yields from the five amounts of N were respectively 29·6, 32·4, 39·7, 41·4, 39·3 cwt/acre ($\pm$1·88). Additional phosphate and potash did not increase yield. As at Sutton St. James in 1966, 2·0 cwt N/acre gave most yield, and the response to N was much greater on this deep fertile soil than on less-fertile Oolitic limestone soil at Chipping Norton. Increasing the N from 0·5 to 2·0 cwt/acre increased seed size but plots with 2·5 cwt/acre N gave the smallest seed. Additional phosphate and potash increased seed size from plots given 1·0 cwt/acre N, but not from plots given 2 cwt/acre N.

Seed from Sutton St. James was smaller in 1967 than in 1966, but was again larger than seed from Preston Capes and Chipping Norton. Denser plant populations give smaller seed, and the plant population at Sutton St. James in 1967 was nearly three times that in 1966. Despite large differences in seed size from different sites in 1966, there was no difference in the proportion of one, two, three or more seedlings growing from 5500 seeds from each site in greenhouse and field emergence tests.

Plots with all fertiliser treatments ripened early in 1967, and there was no significant effect on germination percentages.

Row width and plant spacing. Crops drilled in rows 5 in., 10 in. or 20 in. apart were compared at Bloxham and 10 in. or 20 in. apart at Chipping Norton. Plant spacing in the rows averaged 2 in. in unthinned braird. Two-thirds of the plots in 10-in. and 20-in. rows at Bloxham were singled to 6-in. spacing in August, and one-third of them were thinned again in the spring to give 12-in. spacing. At Chipping Norton half the plots were thinned to 9-in. spacing in August. *Ramularia* leaf spot defoliated closely spaced plants earliest, especially at Chipping Norton, where the experiments were near the previous year's seed crops.

In both experiments 10 in. between rows produced more seed than 20 in., and at Bloxham yields from rows 5 in. apart were similar to those from rows

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10 in. apart. Also in both experiments thinning rows 20 in. apart decreased yield but increased yield of rows 10 in. apart. Ten-inch and 6-in. spacing at Bloxham, and 10-in. and 9-in. spacing at Chipping Norton, gave the greatest yield. At Chipping Norton closer spacing between and in rows gave smaller seed. At Bloxham the proportion of oversize seed decreased with narrower spacing, but the effect of spacing on seed size was not consistent. Seed germination was not significantly affected in either experiment by spacing between or within rows.

An experiment at Great Staughton on a crop consisting of a mixture of two-thirds male sterile monogerms and one-third multigerm pollinators compared the effect of transplanting in five spacings 10 × 10 in., 15 × 15 in., 20 × 15 in., 20 × 20 in. and 30 × 30 in. Half the plots were "topped" on 5 June when plants were 30 in. tall. Topped plants were 6–9 in. shorter at harvest. Male sterile plants bolted earlier than pollinators, but flowered later. Topping and wider spacing delayed flowering and ripening. Seed yields from the five spacings were respectively 34·0, 34·6, 38·3, 33·8, 25·8 cwt/acre (±1·35). As at Great Gransden in 1966, 20 × 15-in. spacing gave most seed, and topping increased yields of this spacing by 5·8 cwt/acre. The mean effect on seed yield of topping all spacings was not significant. Neither spacing nor topping affected the proportion of monogerm and multigerm clusters produced. Plants in the wide spacings 20 × 20 in. and 30 × 30 in. lodged, developed secondary growth, matured late and produced lighter seed than closer spacings.

Field emergence tests. Samples of seed from experimental plots of 12 multigerm and 12 monogerm treatments from the 1966 harvest selected as having the greatest range of germination in the laboratory were compared in the field. Seed was treated to protect against wireworms and sown by hand $\frac{3}{4}$ in. deep and 4 in. apart. Samples that germinated best in the laboratory, i.e. from direct drilling, early sowing, late harvesting and dense planting, also emerged best in the field. In both tests seed harvested from the same monogerm male sterile line germinated better with a diploid pollinator than with a tetraploid.

Relative emergence of monogerms, i.e. the number of clusters producing at least one seedling in the field expressed as a percentage of germination in the laboratory, was slightly greater (80·0) than of multigerms (74·1). Although results in the laboratory and field were closely correlated with seed from different treatments in the same experiment, those from different experiments were not, and the correlation coefficient was only 0·61.

The significance of fruit size of monogerm varieties. Groups of 10 fruits of the Canadian monogerm variety C.S.42 and an English monogerm variety each weighing 4, 6, 8, 10, 12, 14, 16, 18, 20, 22 and 24 mg were soaked in water for 2 hours, when the germs were removed and dried. Fruits of both varieties had "loose caps" which made dissection easy. More than half the fruits weighing 4 mg were empty, and the proportion containing a germ increased with increasing fruit weight. All fruits heavier than 14 mg contained at least one germ, and 20% of the heaviest fruits contained two germs. Germ dry weight of both varieties was proportional to fruit weight

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when empty fruits and those containing two germs were not included in the calculation. Germ weight of C.S.42 increased faster as fruit weight increased than the English monogerm variety.

The relationship between fruit weight and seedling weight of C.S.42 and of an English monogerm male sterile pollinated either by a tetraploid or a diploid was examined in pots in the glasshouse. Nine fruits from the same weight group, 4–6, 9–11, 14–16, 19–21 and 24–26 mg were sown in each pot, and tests were replicated at least five times. Fewer fruits, 51·1%, produced seedlings from the lightest grade of C.S.42 than from the other grades (81–90%), and 10% of the fruits in the heaviest grade produced more than one seedling. Seedlings were harvested 21, 28, 35 and 44 days after sowing on 23 January, and plant weight increased with increasing fruit weight on each occasion; at the final harvest, plant dry weights from increasing fruit weights were 44·4, 71·3, 79·3, 90·2 and 103·5 mg. With the monogerms from male steriles, more plants emerged, on average 23%, from the cross with the diploid pollinator than from the cross with the tetraploid, but the weight of individual seedlings of the two varieties was similar. Plant dry weights 35 days after sowing increased with increasing fruit weight—75·7, 112·4, 120·8, 129·3 and 115·9 mg; the maximum was from the 19–21-mg grade.

The effect of fruit size of C.S.42 and a triploid monogerm variety on sugar yield of the crop grown from them was examined in the field. Plant population, sugar percentage and sugar yield of the triploid were greater from the large and medium grades than from the small grade. Those of C.S.42 were greatest from the large grade drilled at close spacing and smallest from the small grade drilled at wide spacing. Yields of different treatments were closely correlated with the plant populations obtained, and the effects of fruit size on yield needs to be determined at the same plant population.

Pollen liberation in an open-pollinated crop. For the third year the effect of weather on the liberation of sugar-beet pollen was studied in 1 acre of transplanted seed crop at Broom's Barn of the same multigerm variety as used in 1966. The "Hirst" trap in the centre of the crop was situated 30 in. above the ground, at the level of most flowers, and operated from 16 June to 7 August. The first pollen was collected on 23 June, but severe storms later in the day and on the following day damaged the crop and delayed flowering. The daily catch was small until 30 June, increased rapidly between 30 June and 7 July and was smaller again on the 9 and 10 July, following cooler weather. In the uniformly warm sunny weather from 11 to 18 July, with maximum daily temperatures of 70–80° F and minimum relative humidities from 40 to 50%, more pollen was caught than during any other similar period in the 3 years. The greatest catch in any hour was 50700 grains/m^3 at 9.00 G.M.T. on 13 July. The average pollen catch between 27 June and 31 July was three times as great in 1967 as in 1966. Only 0·44 in. rain was recorded between the 25 June and 23 July, when the weather broke, and little pollen was caught for the remainder of the flowering period. The diurnal periodicity of pollen release was similar to that in 1965 and 1966, with very small concentrations between 1.00 and

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3.00 h G.M.T., gradual increase from 3.00 to 5.00 and a rapid increase between 5.00 and 9.00. Concentration was greatest from 9.00 to 13.00, and then declined gradually until midnight. There was a second peak in the pollen catch during the afternoons on 9 days. Rain during the day invariably decreased the pollen catch, but rain during the hours of darkness was followed by a temporary increase early on 6, 8 and 18 July. The effect was also recorded on 5 and 7 July 1965 and parallels the dry liberation of fungus spores by raindrops reported by Hirst and Stedman.

To investigate whether the density of the pollen cloud during different 24-hour periods influenced seed set, four groups of four monogerm male sterile plants were grown in pots in a glasshouse mixed with red marker pollen producers, and different groups were exposed in the open pollinated crop for 24 hours from 16.00 h on 3, 6, 7 and 12 July. Thirteen per cent of the seedlings growing from seed harvested from control male sterile plants, which were never exposed to the seed-crop pollen cloud, had green hypocotyls, showing that there had been contamination from outside pollen. More seedlings, 28–35%, from seed of all exposed plants developed green hypocotyls, but differences between days were not significant, and for the third year seed set on male sterile plants could not be related to the pollen catch while they were exposed in the crop.

Pollen liberation in crops producing hybrid seed. For the second year the catch in a crop where all plants produced pollen was compared with the catch in two crops where most plants were male sterile. Two square, ½-acre crops, one pollinated by the diploid used in the open pollinated crop and the other by a tetraploid, were planted in identical patterns. Rows ran north to south, and the crop with the tetraploid pollinator was 1000 yards north of the crop with the diploid. The frequency of pollinator rows increased from west to east across the plot. On the western edge there were five rows of male steriles bordered on the east by a pollinator row, and single rows of pollinators were interspersed in rows 31, 52, 63, 69, 75, 78, 81, 83 and 85 eastwards of it. "Hirst" traps were operated at the height of most flowers in the centre of the strips of five and 30 male sterile rows. The catch of pollen from the diploid pollinator in these two positions was 27 and 7% of the catch in the open pollinated crop. In 1966, when the crop was planted with two pollinator rows alternating with five male steriles, the catch was 41% of that in the open pollinated crop. The pollen catch in the centre of the strip of 30 male steriles was 27% of that in the centre of the strip of five male steriles where the pollinator was diploid and 16% where the pollinator was tetraploid.

As in 1966, both diploid and tetraploid pollinators started to flower at the same time. The integrated pollen catch in the centre of five male sterile rows from the tetraploid in 1967 was 47% of that from the diploid, a difference consistent on all days. In 1966 more pollen, 105%, was collected from the tetraploid than the diploid during the first week of July, but less, 87%, during the remainder of the month. In 1967 the diploid pollinator was in the more fertile soil, but the less fertile in 1966; differences between pollen catches in the different crops cannot be attributed solely to genetic differences of pollinators.

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The differences between diploids and tetraploids in the diurnal periodicity of pollen release was consistent in both years; the tetraploid gave a slower increase and later peak of pollen. This could be because the anthers of tetraploids rupture in drier air or because more wind is needed to get the larger pollen grains airborne.

Glass funnels, 150 mm diameter, were exposed at the level of most flowers in the centre of strips of 30, 20, 10 and 2 male sterile plants for 3 days on three occasions, and 1 day on nine occasions between 15 July and 1 August. The funnels were thoroughly washed out at the end of each period, and the pollen contents collected either on 8 μ membrane filters or by sedimentation on to cover slips. Pollen catches in the funnels during different periods, and in different crops, were proportional to those on "Hirst" traps. The average funnel catch for all periods in both crops in the centre of strips of 2, 10, 20 and 30 male sterile rows expressed as percentages were respectively 100, 61, 38 and 27. The decrease in pollen catch as the number of male sterile rows increased was similar whether the pollinator was diploid or tetraploid. From 15 July to 1 August 63% of the pollen collected from the diploid was collected from the tetraploid using funnels and 60% using "Hirst" traps. The relationship between the pollen catch on funnels or "Hirst" traps at different positions in the crops was not affected by the direction of the wind.

The average yield of seed per plant in the male sterile strips tended to be greater in the centre of a strip of five male sterile rows than in a single male sterile row bordered by two pollinator rows or from the central row of 30 male sterile rows, but differences were barely significant at the 5% level. If this was a real effect, then the explanation could be that inter-plant competition from more vigorous pollinators suppressed growth of the single male sterile row, whereas the small pollen concentration in the centre of 30 male sterile rows limited yield in this position.

In 1966 44% of seed produced by the tetraploid germinated in the laboratory, whereas 62% produced by the diploid did, and in 1967 more seedlings grew from seed harvested from diploid male sterile plants exposed for two periods in 3 days in the crop with the diploid pollinator than with the tetraploid. (Scott)

Sugar-beet manuring

The trials reported below dealing with magnesium, peat remnant, N Na dung and fertilisers were done in co-operation with the British Sugar Corporation in 1966. The other experiments reported were on Broom's Barn farm in 1967.

NPKNa on peat remnant. Six trials in this new series were done at sites where the peat layer had become so thin that the plough penetrated the clay subsoil. The amount of peat in the plough layer, determined by loss on ignition, ranged between 20 and 40%. 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 in a factorial design.

On average, the responses to all nutrients were small; N gave an economic response at only two sites. The best dressing of phosphate on average was 0·75 cwt/acre, but one site was particularly responsive, and even 1·5 cwt/acre was too little for maximum yield. Potash at 2·0 cwt/acre was best on average, but there was little response to agricultural salt.

NNa dung. The object of these trials was to determine the effect of agricultural salt (5 cwt/acre) and of dung (12 ton/acre), on the response of sugar beet to N. The average yields from the six trials in 1966 confirmed the usual finding that on most soils sodium is a valuable nutrient for sugar beet. In contrast, on a silt soil near the Wash it decreased yield. Where dung was applied, sodium was not needed, presumably because of the sodium and potassium in the dung. The optimum N dressing was little affected by either sodium or dung.

Fertiliser types. Two trials in Scotland tested two amounts of N, P_2O_5, K_2O and Na applied as "Chilean Potash Nitrate", as "I.C.I. No. 4 compound", as ammonium sulphate or as "Nitro-Chalk". P, K and Na were made up to a uniform dressing with superphosphate, muriate of potash and salt. Yields of sugar were similar with the four types of fertiliser, but "Chilean Potash Nitrate" usually gave the smallest, significantly so at one site. The greatest yields were from the compound. Ammonium sulphate and "Nitro-Chalk" gave the same yield.

Form of fertiliser and time of application. Anhydrous ammonia and liquid fertilisers were again tested at Broom's Barn. Anhydrous ammonia was injected at 6 in. depth on three dates: 27 February on the ploughed land; 3 April on the partially prepared seed-bed; 2 June injected either close to the plants or midway between the rows before singling. These treatments were compared with N in the seed-bed 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.

Applying anhydrous ammonia on 27 February gave 55·4 cwt/acre sugar, and applying it on 3 April gave 56·6 cwt/acre sugar. Injecting the ammonia along the rows was less effective, as in 1966 (*Rothamsted Report* for 1966, p. 294). This method gave 53·7 cwt/acre sugar when the ammonia was injected close to the plants and 54·6 cwt/acre when injected midway between the rows. The liquid sprays and the "Nitro-Chalk" gave similar yields to ammonia applied before sowing.

Magnesium. Six trials, 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. The beet on two of the trials had no deficiency symptoms and magnesium did not increase yield. However, averaging the results of all six trials, 2·5 cwt/acre kieserite which cost 30*s*. increased sugar yield by 3·5 cwt/acre, worth about £7. There was no evidence that 5 cwt/acre kieserite increased yield more than did 2·5 cwt/acre. Dolomitic limestone had a small effect at all the sites. There was a

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positive interaction between magnesium and nitrogen in sugar yield; at the site where beet showed most symptoms, this interaction was large and significant. Magnesium and sodium did not interact on average.

Barley grew better on some plots on the site of a previous magnesium trial, and this better appearance was reflected in a response of nearly 4 cwt/acre of grain to magnesium fertiliser applied 2 years before. (Draycott)

Magnesium uptake. In sugar-beet crops affected by magnesium deficiency symptoms are usually most definite during July and August. Factors affecting the magnesium status of sugar-beet plants grown on soils with little exchangeable soil magnesium were examined in two experiments in 1967. One was on a light soil at Broom's Barn (0·304 meq. Mg/100 g soil) and the other at Herringswell (0·345 meq. Mg/100 g soil). Kieserite, kainit and magnesium limestone were tested, but only a few plants developed deficiency symptoms, and none of the magnesium fertilisers increased any of the components of yield at either site. Analysis of samples of 24 plants/plot taken at monthly intervals showed that magnesium uptake was fastest during June and July. (Draycott and Durrant)

Effect of previous cropping. This is the second of these trials to be completed at Broom's Barn, which test the effect of previous cropping and nitrogen manuring on the yield and quality of sugar beet. The preparatory crops were grown on Flint Ridge field in 1966 (see *Rothamsted Report* for 1966, p. 293).

In 1967 the plots were split for the N dressings (0, 0·5, 1·0 and 1·5 cwt/acre) for the sugar beet and the yields are in Table 12.

TABLE 12

Nitrogen removed by preparatory crops in 1966 and yields of sugar beet in 1967 with different nitrogen dressings

	N applied in 1966	N offtake in 1966	Yield of sugar (cwt/acre) in 1967 N dressing (cwt/acre)			
Preparatory crop	(lb/acre)	(lb/acre)	0	0·5	1·0	1·5
Barley	56	68	63·3	65·0	65·8	65·3
Wheat	90	85	68·6	73·0	72·3	64·9
Potatoes (Low N)	56	86	57·3	67·2	69·9	66·2
Potatoes (High N)	168	138	60·7	68·2	65·6	68·4
Ryegrass	56	67	59·6	68·6	66·6	66·8
Barley (undersown trefoil)	56	88	64·7	64·4	64·3	62·5

The nitrogen required for maximum sugar yield depended greatly on previous cropping and manuring; it was 1·0 cwt/acre after barley and potatoes (Low N); 0·5 cwt/acre after winter wheat, potatoes (High N) and the ley; after barley undersown with trefoil N was not needed.

A further trial was begun in 1967 on Blackhouse field, and will be cropped with beet in 1968. Yields of the preparatory crops were 31 cwt/acre barley grain, 42 cwt/acre winter wheat, 14·0 ton/acre potatoes (0·5 cwt/acre N) and 16·1 ton/acre (1·5 cwt/acre N). Ryegrass yielded 54 cwt/acre of dry matter. (Draycott)

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Fertilisers on rotation crops. This long-term experiment, which tests fertiliser dressings on a rotation of sugar beet, winter wheat and barley, completed one cycle in 1967. (For details of the fertiliser dressings see *Rothamsted Report* for 1965, p. 279, Table 7.)

The cereals gave a large response to nitrogen in 1967 (Table 13), but

TABLE 13

Yield responses of rotation crops to fertiliser treatments in the third year of the long-term experiment

	Wheat grain (cwt/acre at 85% DM)	Barley grain (cwt/acre at 85% DM)	Sugar-beet sugar (cwt/acre)
Mean yield	38·8	27·9	58·9
Response to:			
N_1	+16·2	+12·1	+0·8
N_2–N_1	−4·1	+5·6	+2·7
P_1	+3·7	−0·5	−3·0
P_2–P_1	+0·3	+3·7	+2·2
K_1	+0·7	+2·2	+2·4
K_2–K_1	−0·7	+3·2	+1·8
Na	−1·0	+3·0	+9·6
Dung	+0·9	+1·0	+0·4
Compound 1	+16·7	+14·7	+7·7
Compound 2–Compound 1	−4·7	+2·3	−1·5

sugar beet gave an unusually small response. Responses to P and K were small with all crops, but as usual sugar beet gave a large response to Na. Dung was of little value in increasing yield, and there was small return from using the large dressing of compound (C_2) rather than the normal (C_1) dressings. (Draycott and Durrant)

Plant spacing

Twin rows on ridges. This experiment compared the yield of pairs of rows (twins) of sugar beet 10 in. apart and 20 in. between adjacent rows of the twins with single rows 20 in. apart. The twin rows were sown either on a flat seed-bed or on ridges thrown up in the winter at 30-in. centres. When flattened the twin rows could be fitted on them. This practice allows sowing earlier than is sometimes possible when ploughed land has to be worked down to a level seed-bed in the spring. The P and K fertilisers were applied to all the plots in the winter before ridging. One hundred and twenty units/acre N were applied either (N1) as a single dose to the soil before sowing, or (N2) as three doses of 40 units to the seed-bed, on seedling emergence and at singling or (N3) as 2 doses of 60 units on seedling emergence and at singling. Pelleted seed var. Monotri was sown at 4 in. spacing on 14 March and the experiment sprayed all over with 2 lb/acre of "Pyramin" on 21 March, and with 2½ lb "Pyramin" and 2 lb "Citowett" in 45 gal/acre water on 11 July. No hand or machine cultivating was done, but double seedlings were hand-singled on 31 May and some large weeds pulled on 24 July.

The plots were harvested by hand on 23 October. Averaged over spacings, N1, N2 and N3 yielded 64·9, 63·4 and 60·2 cwt/acre sugar respectively; the split dressings yielded less than the seed-bed application. The 20-in.

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rows had a plant stand of 41000/acre, the 10-in. twins on ridges had 50000 and those on the flat had 52000; corresponding sugar yields were 65·6, 62·3 and 60·8 cwt/acre. Yield was inversely proportional to plant population, which was evidently too dense on all treatments to give maximum yield. The experiment needs repeating with a uniform number of plants/acre to determine how the plant distributions obtained with the different row arrangements affect yield. About 12% of the plants bolted, fewer on the twin rows on the flat than on ridges. No treatment affected sugar percentage. The beets on the narrow rows on ridges tended to tilt outwards, which would make mechanical topping difficult.

Sowing date and plant population. Plots of Sharpe's E sown on 13 March, 4 April or 27 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; 1965, p. 277; 1966, p. 295. The plots were harvested on 7 December 1967, and Table 14 gives the results.

TABLE 14

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

Plant spacings	6 in.	12 in.	20 in.	Mean
Plants 1000/acre	48	26	16	30
Date sown:				
13 March	64·2	55·8	52·3	57·4
4 April	59·5	58·0	54·0	57·1
27 April	51·6	54·1	49·4	51·7
Mean	58·4	56·0	51·9	55·4

On average the narrower spacings gave greater sugar yields. The two early sowings gave similar yields, but the late sowing gave less. Sowing date did not influence the effect of plant spacing. Sowing date had little effect on sugar percentage but wider spacing decreased it; averages were 16·3, 16·0 and 15·5% respectively for the three plant densities. (Hull and Webb)

Nitrogen, spacing and irrigation. This experiment tested the influence of density of plant stand, nitrogen fertiliser and irrigation on yield, rooting depth 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 the same as in 1966 (see *Rothamsted Report* for 1966, p. 296).

The early part of the growing season was wet, and rain exceeded transpiration by sugar beet until the end of May. From the beginning of June until October the soil-moisture deficit, as estimated from Penman's tables of average potential evaporation, increased on the unirrigated plots to more than 6 in. On the irrigated plots 5·5 in. of water was applied, mainly during July, to keep the deficit at about 1·5 in.

On four plots the moisture in the soil to a depth of 4 ft was measured every 2 weeks using neutron moderation. The integrated net loss of water from the soil to 4 ft depth obtained from these measurements agreed with the estimated loss from tables. However, during July and August the close-spaced plants (55000/acre) used more water than the estimated need. In

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the same period the measurements and estimates agreed for the wide-spaced plants (7500/acre), but later in the season these plants used less than estimated. This is probably because the shallow root systems of the widely spaced plants exhausted the moisture in the soil they had explored and could not use as much of the deeper water. The closely spaced plants rooted deeper and reached more soil moisture.

On the irrigated plots with the wide spacing, the irrigation water kept the deficit near to 1·5 in. throughout the season as planned, but with the close spacing the deficit increased to 3·5 in., to some extent confirming the results on the unirrigated plots.

The mean yields of sugar from the four spacings were: S1—52·3, S2—65·7, S3—70·9 and S4—67·8 cwt/acre. Sugar yields for the nitrogen dressings were NO—59·5, N1—65·4, N2—66·3 and N3—65·6, and plant spacing only affected yield response to N at S4, where large nitrogen dressings decreased yield of sugar considerably.

The mean increase in sugar yield from irrigation was 6·1 cwt/acre. Averaging the nitrogen treatments the four plant spacings gave responses to irrigation of +5·7 (S1), +4·6 (S2), +7·9 (S3) and +6·3 (S4). As averages of the plant spacings, the four nitrogen dressings gave responses of +3·5 (NO), +5·3 (N1), +7·5 (N2) and +8·3 (N3) to irrigation. (Draycott)

Herbicides

Fieldman reported few instances of herbicides damaging sugar-beet seedlings this year. We had no damage where herbicides were used routinely at Broom's Barn, but excessive doses did decrease yield on experiments. One experiment on Flint Ridge field tested pyrazon at 1·4 and 2·8 lb and lenacil at 0·6 and 1·25 lb either incorporated into the seed-bed 10–24 days before sowing on 17 or 27 April or immediately after sowing the beet. No treatment seemed to damage the seedlings, and none influenced the yield of 19·1 ton/acre of roots at 16·3% sugar content. Lenacil at 1·25 lb worked into the soil before drilling decreased plant population by 5000 on an average density of 35 000/acre. In the experiment made by Mr. W. E. Bray of Norfolk Agricultural Station (cf. *Rothamsted Report* for 1966, p. 297) pyrazon at 6 lb a.i./acre incorporated in the seed-bed decreased yield by about 2½ ton/acre, and by more than 3 ton/acre when applied immediately after drilling. Lenacil at 2 lb/acre incorporated in the seed-bed decreased yield by 1 ton/acre, but not when applied after drilling.

Hormone weed-killers. Continuing tests of the effect of cereal spray drift or contamination, sugar beet were sprayed either 6 weeks after sowing with MCPA, MCPB or CMPP at $\frac{1}{50}$ and $\frac{1}{100}$ concentration recommended for killing weeds in cereals, or 10 weeks after sowing with MCPA at $\frac{1}{20}$ and $\frac{1}{50}$ the recommended concentration. No symptoms of damage appeared on plants sprayed 6 weeks after sowing. Plants sprayed after 10 weeks with $\frac{1}{50}$ concentration showed moderate symptoms of spray injury 1–2 weeks after spraying. Those sprayed with $\frac{1}{20}$ concentration were severely affected; and for a short time they grew more slowly than the others and were

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attacked by pigeons. All plants grew, but many of those sprayed with the greater amount were abnormal in shape, with an elongated neck at harvest. Because the early sprays caused no symptoms, plots sprayed with the $\frac{1}{100}$ dilution were not harvested. All materials sprayed at $\frac{1}{50}$ decreased yield by between 2·5 and 6·5%, but the plants that showed damage yielded as much as those sprayed early that had no leaf symptoms. MCPA at $\frac{1}{20}$ sprayed 10 weeks after sowing decreased yield by 12%, but some of this loss was probably from pigeon damage. (Byford)

Time of sowing and harvesting

The effect of three dates of sowing and harvesting of var. Sharpe's E were tested on Flint Ridge field. Plant population averaged 36 000/acre and was similar on the three sowings. Bolters were 6, 1 and 0% on the early, middle and late sowings respectively. The early April sowing gave the greatest sugar yield on average, but the March sowing only slightly less (Table 15). The late April sowing gave 6 cwt/acre of sugar less than the early April sowing. This is the first occasion in the 5 years of this experiment (see *Rothamsted Reports* for 1963–66) when the first sowing has not out-yielded the second. Delaying harvesting progressively increased yield, but there was no significant interaction between sowing date and harvest date. Delaying sowing decreased sugar percentage by 0·3 and delaying harvesting decreased it by 0·7.

TABLE 15

Yield of sugar from beet sown and lifted on different dates

	Lifting date							
	September 26		November 1		December 8		Mean	
Sowing date:	cpa	%	cpa	%	cpa	%	cpa	%
13 March	48·4	17·2	60·4	16·8	62·0	16·3	57·0	16·8
4 April	48·5	16·9	64·0	16·7	63·0	16·5	58·5	16·7
27 April	46·5	16·9	54·8	16·5	56·4	16·2	52·6	16·5
Mean	47·8	17·0	59·7	16·7	60·5	16·3	56·0	16·7

Cereal and rotation experiments

Frequency of beet and barley. On this phased rotation experiment (see *Rothamsted Report* for 1966, p. 298), sugar beet after barley yielded more than after 2 years of grass, after potatoes in a three-course arable rotation or after continuous beet, when the beet was not given nitrogen. When the beet was given N, it influenced yield more than previous cropping; on average 50 units/acre N gave 66·7 cwt/acre of sugar compared with 57·6 cwt/acre on the no N plots and 63·5 and 62·5 on the 100 and 150 unit/acre N plots respectively. After four successive barley crops, 100 unit/acre N was the optimum dressing. On average for all rotations, the first 50 unit/acre N increased root yield by 2½ ton/acre; more N depressed sugar percentage by 1·5 without increasing root yield appreciably. (Hull and Webb)

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Effect of residues from beet on barley. In 1966 sugar beet was grown without N and with 50, 100 or 150 unit N/acre; this N increased sugar yields from 53·5 to 72·6 cwt/acre and the amount of N in the tops from 0·47 to 1·05 cwt N/acre. These tops were either carted away or spread and ploughed in. In 1967 barley (Zephyr) was grown without N or with 33, 66 or 100 unit N/acre, each amount was tested in all combinations with the N applied in 1966 and with or without ploughed-down sugar-beet tops.

TABLE 16

Yield of barley after sugar beet

(cwt grain/acre at 15% moisture)

	N applied in 1967 (units/acre)				
	0	33	66	100	
N applied in 1966					
0	30·6	38·9	42·2	40·3	±1·15 V
50	31·7	38·0	42·1	39·7	±1·08 HI
100	33·5	38·6	41·2	39·2	
150	35·6	40·8	42·5	38·2	
Tops ploughed-down in 1966					
Without	31·1	38·2	41·0	39·9	±0·82 V
With	34·6	40·0	42·9	38·8	±0·77 HI

V = Vertical. HI = Horizontal and Interaction comparisons.

Without N barley yields were increased both by the residues of the N applied for the beet and by the ploughed-down tops, and together they increased grain yields by 9·0 cwt/acre (Table 16). Two-thirds of this residual benefit seemed to come from the sugar-beet tops. Both sources of residual N also increased yields (and in the same proportions) when the barley was given 33 unit N/acre, but they diminished yields with 100 unit N/acre. It was worthwhile to apply up to 66 unit N/acre for the barley (this increased mean yields by 9·1 cwt grain/acre), but 100 unit N/acre diminished yields, and then they were little larger than with only 33 unit N/acre. The increases from the N given for the barley were diminished by the N given for the sugar beet and by the ploughed-down tops. (Widdowson)

Nitrogen on barley. On the light sand at Herringswell "Nitro-Chalk" top-dressings on 15 May giving 0, 40, 80 or 120 unit/acre N were tested on an Impala barley crop sown on 15 February. The crop had received 3 cwt/acre of a 20:10:10 compound fertiliser when sown. The four N top dressings yielded respectively 40·1, 42·3, 40·6, 38·7 cwt/acre of grain at 85% dry matter and 66·5, 73·1, 76·2, 68·2 cwt/acre of dry matter in grain and straw. (Draycott and Webb)

Broom's Barn Farm

The pump in the well was lowered by 52 ft to approx. 250 ft to improve the yield, which was inadequate for irrigation in July.

Ploughing was completed by mid-January 1967. Whitepatch field was

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deep cultivated and levelled during the summer. About 30 acres of light land remained unploughed at the end of the year.

Cereals. During good weather early in February, 13 acres of Cappelle wheat were sown on Marl Pit, 21 acres of Impala barley on Dunholme and 21 acres of Zephyr barley on Blackhouse and Brome Pin. The 15 acres of Zephyr barley on Bullrush and 17 acres of Kloka wheat on Hackthorn were drilled on 6–8 March. Hackthorn was undersown with an S.22 rye-grass and clover mixture. All the barley was drilled at 1½ cwt/acre of seed, and all except Blackhouse had 4 cwt/acre of 20 : 10 : 10 compound fertiliser combine-drilled; Blackhouse had 2 cwt/acre of 20 : 10 : 10 compound, and the crop was top-dressed in April with 2 cwt/acre of 21% N "Nitro-Chalk". Cappelle wheat on Marl Pit was combine-drilled with 2 cwt/acre of 6 : 15 : 15, and Kloka on Hackthorn with 3½ cwt/acre of 20 : 10 : 10 compound fertiliser. Winter wheat on Little Lane and Marl Pit was top-dressed with 80 units/acre N in late March.

The winter wheat on Little Lane and the early sown spring cereals on Blackhouse and Marl Pit were sprayed with "Actril C" and Dunholme and Bullrush with "Buctril M". Brome Pin was sprayed in strips with "Actril C" and "Cambilene", which has been frequently used in previous years. No difference in surviving weeds was seen either in the growing crop or on the stubble. The undersown wheat in Hackthorn was sprayed with "Legumex Extra". Blackhouse was sprayed with barban against wild oats. All herbicide sprays were between 24 April and 17 May.

Harvest lasted from 31 July to 25 August. Moisture content of grain ranged from 15 to 18·5%; yields are in Table 17. A sample of wheat from Little Lane won the Stanningfield and District Agricultural Club's Wheat Cup. Straw on Little Lane was burnt, and was baled and carted from all other fields.

Winter wheat on White Patch and Little Lane established well after drilling in early October. All but 2 acres of the Holt was drilled with winter wheat on 5 December following sugar beet.

TABLE 17

1967 Cereal yields at 15% moisture

	acres		cwt/acre
Little Lane	23	Cappelle wheat	43·5
Marl Pit	13	Cappelle wheat	36·5
Hackthorn	17	Kloka wheat	35·7
Blackhouse and Brome Pin	21	Zephyr barley	33·2
Bullrush	15	Zephyr barley	37·2
Dunholme	21	Impala barley	31·8

Fodder crops. The S.22 ryegrass and clover mixture on White Patch grew well after receiving 3 cwt/acre of 20 :10 :10 compound on 8 March and a further 40 unit N/acre on 17 April. It was cut partly for silage and partly for hay in early June.

The S.22 and red clover mixture established well under the spring wheat on Hackthorn, but pigeons were damaging it in December.

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Sugar beet. The basic fertiliser on all the sugar beet was 6 cwt/acre of "Kainit" applied in the autumn and 6 cwt/acre of 20 : 10 : 10 compound on the seed-bed. The Holt was mainly commercial crop, but all of Flint Ridge was occupied with experiments. Sowing started on 13 March, and about half the crop was drilled before the end of the month. The remainder was drilled as weather permitted during April. Most of the crop was sown with graded seed from precision drills and band-sprayed with the herbicide pyrazon. The good stand established was readily thinned and cleaned by hand. The crop was sprayed twice with systemic insecticide to control aphids and yellows. Although the water deficit reached about 6 in. in July, only the headland had 2½ in. of irrigation water. Lifting started on 25 September and continued smoothly through the autumn to finish on 15 December. All undelivered roots were clamped on the loading platform. Yields from the 33 acres averaged 16½ ton/acre of clean roots at an average sugar content of 16·1%. This ranged from 18·4% in late October to 14·4% in January. Mean dirt and top tare was 12·7 lb/cwt. The country's average yield this year was 15·5 ton/acre of roots at 15·8% sugar.

Livestock. During September and October 1966, 54 Hereford-cross and 28 Friesian steers were bought at an average liveweight of 600 lb for the yard. Half were fed *ad lib* silage and a maximum of 10 lb/head/day of rolled barley and kibbled beet-pulp nuts with a protein supplement, and half fed 16 lb/head/day of this mixture without silage. The average daily liveweight gain was 1·76 lb for those with silage and 2·12 lb for those without. All cattle were sold between 29 March and 6 June.

Eighty-two Hereford-cross steers were bought in September and October 1967. (Golding)

Weather records

TABLE 18

Monthly means of measurements at Broom's Barn in 1967 and the differences of these from the long-term means at Mildenhall

Month	Mean temperature (° F)	Difference (° F)	Mean daily sunshine (hours)	Difference (hours)	Monthly rainfall (in.)	Difference (in.)
January	38·6	+0·5	2·19	+0·49	1·08	−0·82
February	41·5	+2·5	3·08	+0·57	1·50	+0·09
March	45·3	+2·0	5·39	+1·39	0·71	−0·54
April	45·3	−2·5	4·42	−0·94	2·36	+0·65
May	51·3	−2·1	5·50	−1·00	2·42	+0·80
June	56·9	−2·1	6·59	−0·45	1·34	−0·15
July	63·9	+1·7	6·71	+0·47	2·33	−0·09
August	61·5	−0·6	5·40	−0·56	1·33	−0·70
September	57·0	−1·1	3·76	−0·95	1·81	−0·20
October	52·0	+0·7	3·23	−0·23	4·20	+2·28
November	41·7	−2·9	2·18	+0·30	2·34	+0·29
December	38·1	−2·4	2·07	+0·65	2·02	+0·22
Year average	49·4	−0·6	4·21	−0·03	23·44	+1·83

Sunshine hours for 1967, 1539·9

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Staff and visiting workers

R. K. Scott left at the end of the year for Nottingham University School of Agriculture. In June he visited the sugar-beet seed industries in Western Europe. A. P. Draycott, R. Hull and R. K. Scott attended the International Institute of Sugar Beet Research Winter Congress in Brussels in February, and R. A. Dunning attended the 6th International Plant Protection Congress in Vienna in September. R. Hull worked by invitation in the Department of Plant Pathology, University of California, Davis, from March to September; he contributed to the 4th British Insecticide and Fungicide Conference in Brighton in November, and the Conference of the Pacific Division of the American Phytopathological Society at Bozeman, Montana.

We invited the public to a "Farm Walk" at Broom's Barn and 240 attended. A three-day training course was attended by 26 sugar factory fieldmen. Numerous visitors included 50 N.A.A.S. Advisory Entomologists for a day and scientists from several foreign sugar industries. Several winter meetings were cancelled to avoid the risk of spreading foot and mouth disease to our cattle.

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