ROTHAMSTED RESEARCH

Report for 1964

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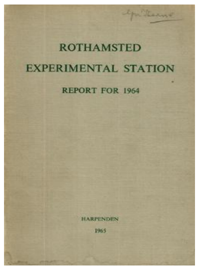

Broom's Barn Experimental Station

R. Hull

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BROOM'S BARN EXPERIMENTAL STATION

R. HULL

R. K. Scott was appointed to study problems of the sugar-beet seed crop and D. A. Cooke as nematologist. R. Hull and R. A. Dunning attended the winter congress of the International Institute of Sugar Beet Research in Brussels, R. Hull the summer meeting in Denmark and P. B. Tinker the 8th International Soil Congress in Bucharest. G. D. Heathcote contributed to the 12th International Congress of Entomology in London.

About 300 people saw the laboratories, field experiments and farm on the open day in July, and groups of farmers, research workers and agriculturists on other days. Steckling inspectors and sugar-beet and mangold seed merchants came in July and in October to discuss recent experiments on the seed crop and to arrange the steckling inspections. A 2-day course of instruction on pests, diseases and fertilisers was attended by 33 fieldmen from the sugar factories. The monthly lectures during the winter proved popular, and each has been attended by 60–100 visitors.

The object of our work is to gain information that will increase yields and quality of sugar beet, and cheapen production, and we pay particular attention to fertiliser use and control of pests and diseases. Most of the work reported has practical application, and results quickly reach growers through the field-staff of the British Sugar Corporation and the National Agricultural Advisory Service. Methods of growing sugar beet seem likely to change greatly in the future; monogerm seed and new herbicides may obviate most or all handwork, possibly with different plant spacing than used at present. We study how these changes will affect yield, fertiliser requirements, and pest and disease control. Work on seed crops increased this year. Progress with spring mechanisation of the root crop demands seed of uniform size with good germination. Plant breeders will no doubt help to produce such seed, but we must also determine how to grow seed crops to produce the different quality of seed now needed and to avoid diseases spreading between seed and root crops.

Surveys assess the incidence of pests and diseases in both the crop and the sources from which they spread to the young root crop in the spring, so that growers can be warned to take appropriate control measures. Growers readily improve their own crops, for example by spraying them with insecticide, but are less ready to use treatments that affect diseases and pests over a wider area than their own farm, such as fumigating aphid-infested mangold clamps or spraying seed crops lightly infested with aphids. Progress with such desirable measures of farm hygiene calls for arrangements to do such things on a co-operative basis.

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Yellows and Aphids on Sugar Beet

Up to the middle of June, few green aphids infested sugar beet, but then the infestation increased rapidly and reached an average of one aphid per plant by early July. This pattern of aphid development differed from any of the previous 5 years, because the infestation started as in 1962 and 1963, when yellows was rare, but from mid-June onwards was similar to 1960, when yellows was prevalent locally and its incidence averaged 22% at the end of August. Comparable aphid infestations in sample fields in the 1940s and 1950s had led to severe local attacks of yellows, with average yellows incidence of about 20%. In the third and fourth weeks of June, therefore, the sugar factories sent spray warnings to growers in areas where yellows most regularly occurs, and 203,000 acres were sprayed with insecticide. Yellows incidence at the end of August averaged only 4·3%; nowhere was the disease prevalent, and crops remained relatively green throughout the autumn, whether sprayed or not. Eighteen widely distributed experiments showed little effect of sprays on yellows incidence, whether early (2·7% of plants with yellows), at the spray warning (2·0%) or late (2·1%) compared with 2·8% on unsprayed plots.

The small incidence of yellows probably reflects several factors: (1) the aphid infestation was late; (2) scarcity of sources of the virus in spring after two years in which yellows has not spread extensively; (3) insecticidal sprays checked the aphid infestation and prevented the spread of virus that was usual during the summer of past years. The following section records observations on some of these factors.

Weeds. In the spring fieldmen again collected over-wintering weeds from sheltered sites adjacent to mangold clamps, beet seed crops or fields that carried sugar beet in 1963. Thirty-two per cent of the samples were infested with aphids, four times the proportion in 1963, but again few of the aphids transmitted beet viruses to test plants in the glasshouse.

As in 1963, aphids were not found in the spring on wild beet (*Beta maritima*) on the Suffolk coast, probably because they were so scarce in the autumn of 1963 rather than because of unfavourable winter weather.

Mangold clamps. Fieldmen again surveyed mangold clamps during late April. Of 2,597 farms in beet-growing areas, 1,168 grew mangolds, fodder beet or red beet, and 548 still had clamped mangolds; 51 of these contained aphids, but only 3 had large infestations.

TABLE 1

The incidence of mangold clamps in sugar-beet areas and of yellows in sugar-beet crops

	% of farms growing mangolds	% of clamps infested with aphids	No. of aphid-infested clamps per sq mile	% V.Y. at end of August (specific field counts)
1957	60 (approx.)	53	0·71	42·0
1961	53	46	0·52	21·2
1962	51	20	0·11	1·9
1963	48	4	0·02	1·5
1964	43	9	0·07	2·0

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During the last 5 years the number of aphid-infested clamps per square mile in late April has paralleled the incidence of yellows at the end of August in beet fields in the area surveyed (Table 1). The number of farms growing mangolds is decreasing steadily.

Tests of aphids from 16 samples of mangold shoots showed that *M. persicae* from 3 sites had beet yellows virus (BYV), some of those from one site had beet mild yellowing virus (BMYV) and from another beet mosaic virus (BMV).

Winged aphids. In 1964 sticky traps at 8 sites in east England caught fewer than a third of the winged aphids caught in 1963, but aphids flew earlier in 1964. *A. fabae* were few; also *M. persicae*, except at some sites in Norfolk and Suffolk during July. Many more beet aphids were caught on a sticky trap in the sugar-beet root crop at Broom's Barn than in a nearby sugar-beet seed crop.

Seed crops. Samples of shoots and leaves (134) collected between the middle of May and the end of June from 30% of the known beet-seed crops were examined for aphids in the laboratory. Only 3 adult apterae and 17 nymphs of *M. persicae* were found on shoots and leaves from more than 2,600 plants. The first black and green aphids were found in the first week of June. They multiplied slowly, and at the end of June about a third of the crops were lightly infested with black aphids. Few seed crops were sprayed with insecticides this year.

Samples of sugar-beet stecklings from 69 beds, grown in plots at Broom's Barn, averaged 0·13% plants with yellows in June. The average incidence of yellows in 30 *in situ* seed crops was 0·4% and of downy mildew 0·8%. *In situ* crops raised without cover in areas where root crops are few had more plants with yellows than crops raised under cereal cover crops, but downy mildew was most prevalent in *in situ* crops raised under cereal cover in south-east Lincolnshire and west Norfolk. Few plants had yellows in 22 mangold seed crops and no crop had over 1%.

In the autumn aphids were few, and beet and mangold steckling beds had correspondingly few plants with yellows; the average incidence in sugar-beet stecklings was 0·07% and in mangold stecklings 0·46%. Of 152 sugar-beet steckling beds, only one was rejected under the certification scheme because over 1% of plants had yellows. Downy mildew was prevalent in some steckling beds in the marshland area of west Norfolk. Of 144 mangold and red-beet steckling beds, 10 (7%) had more than 1% plants with yellows. Of 96 steckling beds in the Holland division of Lincolnshire, 23 had more than 1% plants with cucumber mosaic virus, and the average for the area was 1·7%. This incidence has never been seen before. Growers were advised to destroy the worst affected beds because diseased plants would give no seed, and to cull infected plants from the others.

Effect of yellowing viruses on yield. A series of experiments was started to re-assess the effect of yellows viruses on beet yield. Some plots of Sharpe's E and of the yellows-tolerant variety TN 59/5 were infected with BYV or BMYV on 27 May, 23 June, 16 July or 10 August, and others

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were kept as free as possible from yellows with insecticide. When downy mildew spread into the plots, TN 59/5 proved to be the more susceptible variety. The yellowing of the leaves from downy mildew and drought made it impossible to assess the incidence of BMYV.

Both varieties averaged 46·9 cwt/acre of sugar. Plots with BYV gave 4 cwt/acre less sugar than those with BMYV. Mean sugar yields for the four dates of infection and the uninfected plots respectively were 36·5, 42·9, 47·2, 53·5 and 54·4 cwt/acre. TN 59/5 yielded more than Sharpe's E on the plots infected earliest with virus (average for both viruses 37·7 and 35·3 cwt/acre respectively), but less on the uninfected plots (50·5 and 58·3 cwt/acre). Sharpe's E lost more sugar from yellows than TN 59/5, as expected, but the small yield of TN 59/5 on the uninoculated plots suggests that it lost more than Sharpe's E from downy mildew. The earliest infection with BYV lowered the sugar yield of Sharpe's E from 58 to 24 cwt/acre and of TN 59/5 from 50 to 37½ cwt/acre. (Heathcote)

Insecticides

Experiments tested methods of using both new and old insecticides most efficiently and with the least risk to organisms other than the pest against which they are applied.

On stecklings. Of three field trials made in 1963–64, only the one at Broom's Barn was infested with aphids. In this trial 10–12 lb/acre of Sharpe's Klein E mother seed was drilled on 2 August $\frac{7}{8}$ in. deep at 1½ in. spacing. Menazon seed-dressing applied at 4% by weight of active ingredient (7·7 oz a.i./acre) was compared with 5% menazon granules (JF 1262) drilled in the row with the seed (17·2 oz a.i./acre). The seedlings became infested as they emerged on 12 August by winged green and black aphids; those drilled with insecticides had fewer aphids than the controls on 12 and 16 August, but not on 23 August, when aphids were fewer and predators active. Both treatments prevented the seedlings being colonised by apterae; a demeton–methyl spray on 16 August (7 oz a.i./acre) was less efficient. Yellows incidence was less than 0·2% on 25 October. Some plants from each plot were transplanted in March 1964, and the percentage with yellows recorded later was: control, 4·1; spray, 2·6; seed treatment, 2·3; granule treatment, 2·9. The incidence of yellows on plots given the last two treatments was not affected by applying insecticide to the plants after they emerged.

In a similar trial at Broom's Barn drilled on 14 July 1964 seedlings were infested as soon as they emerged. This trial included menazon seed-dressing applied at 4% by weight of active ingredient (3·5 oz a.i./acre), two formulations of 5% menazon granules drilled in the row with the seed (JF 1262 at 18 oz a.i./acre and JF 1690 at 16 oz a.i./acre) and demeton-S-methyl spray (7 oz a.i./acre on 27 July); ordinary commercial $\frac{8}{64}$–$\frac{10}{64}$ rubbed and graded Sharpe's Klein E seed was used. On 23 July all the menazon treatments controlled alatae, but 4 days later none did so. Green apterae were controlled by all treatments on 23, 27 and 31 July, but thereafter the infestation also decreased on the untreated plots; black apterae were similarly

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controlled by all treatments except JF 1690 granules, which were ineffective after 23 July.

Yellows incidence on 16 September and 19 October respectively was: untreated plots 20%, 45%; menazon seed-dressing 4%, 13%; JF 1262 granules 6%, 12%; JF 1690 granules 9%, 19%; demeton-S-methyl spray 7%, 21%. Menazon seed-dressing controlled aphids and yellows as effectively as did menazon granules (containing 5 times as much insecticide) drilled in the row with the seed.

Menazon seed-dressing incorporated in the coating of pelleted seed (4% by weight of active ingredient on the seed before pelleting) was also tested in the same trial using "Filcoat" pelleted Bush monogerm seed. Aphids were more numerous on seedlings from the untreated pelleted seed and fewer on the menazon-dressed pelleted seed than on the untreated and menazon-dressed non-pelleted seed respectively. Yellows incidence on 16 September and 19 October was as follows: untreated pelleted seed 17%, 44%; menazon-dressed pelleted seed 3%, 9%.

On root crops. Two field trials tested commercial aphicides for control of aphids and yellows. At Bramford, Ipswich, despite an average of 1 green apterous aphid per plant at the time of treatment on 24 June, increasing on unsprayed plots to 4 green and 10 black apterae on 7 July, yellows incidence was only 2% on the treated and the untreated plots on 8 September.

At Whepstead, Bury St. Edmunds, there were 5 green apterae per plant on untreated plots on 8 July, 17 at the time of insecticide treatment on 10 July, 14 on 13 July, 11 on 21 July and 3 on 28 July. The comparative aphicidal efficiency (mean decrease in aphid population) of five materials tested, based on counts made on the fifth, thirteenth and twentieth days after treatment, were: menazon spray (4 oz a.i./acre) 75%, formothion spray (7·5) 76%, demeton-S-methyl spray (3·1) 86%, disulfoton granules (16) 94%, phorate granules (24) 96%. Yellows incidence (5·3% on 15 October) was not affected by the treatments.

A field trial at Broom's Barn compared disulfoton, menazon (JF 1262) and two rates of menazon (JF 1690) granules placed through knife coulters 3·1 in. deep in the soil and 3·3 in. to one or both sides of the beet rows on 10 June. The previous day six sugar-beet plants infected with BMYV had been planted in each plot, and one set of plots had been sprayed with demeton-methyl. The apterous green aphid population rose from 1 per plant on 8 June to nearly 7 on 25 June and then fell. Further demeton-methyl sprays, and a disulfoton granule top-dressing applied on 25 June almost eliminated aphids by 2 July. Yellows incidence on the control plots was 2% on 17 July, 19% on 19 August, 39% on 15 September and 48% on 10 October (400 infected-plant-weeks). Incidence was decreased most by disulfoton granules placed on both sides of the plant (31% decrease by 16·7 oz a.i./acre) and least by disulfoton placed on one side (14% decrease by 19·6 oz). Despite these effects on yellows, no treatment affected sugar yield at harvest in early November.

Menazon seed-dressing was tested on several varieties of dieldrin-treated seed in trials in several factory areas (see Fungicide Seed Treatment

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below). Menazon seed-dressing (4% a.i. by wt) on untreated seed increased seedling populations on average by 7·2%, but had no effect on EMP-steeped seed; post-singling plant populations were increased by 1·4 and 1·7% on not-steeped and on steeped seed respectively.

Pelleted monogerm seed, incorporating menazon at 4% and 8% a.i. by wt of original seed, was tested in five trials in East Anglia drilled between 14 April and 6 May. Seedling populations on the untreated plots ranged from 7·0 to 16·7 per yard, depending on drilling rates at the different sites. At Broom's Barn the plants on the menazon-treated plots, especially with the large dressing, were duller green and less vigorous than the controls. The small menazon dressing decreased seedling populations by an average of 9% and the large one by 21%; this effect may be partly explained by the fact that the seeding rate was smaller with the menazon-containing pellets because their diameter is larger. Similarly, post-singling plant populations averaged 4% less with the small and 6% less with the large dressings at the three sites where they were counted. In July, at the three sites where aphids were most numerous, green apterae per plant on the control and the two menazon treatments were: Chelmsford 11·9, 3·0, 3·1; Tendring, 7·6, 0·6, 0·4; Broom's Barn, 3·11, 0·35, 1·24. Yellows incidence did not exceed 5% at any site except Broom's Barn, where on 13 September both the control and treated plots had 14% of plants infected. (Dunning and Winder)

Seedling Losses in the Field

Seedling emergence and the subsequent loss of plants up to the time of singling were determined in 1963 in nine sugar-beet fields chosen because damage by birds or mammals seemed likely. On average 180,440 seedlings emerged per acre and 7,200 (4%) were lost from the following causes: cultivations 21%, disease 3%, wireworm 8%, flea beetle 2%, birds 14%, mammals 18%, unknown 34%. Similar observations were made in 1964, but only a few of the fields were selected because damage by birds seemed probable. On average 143,750 seedlings emerged per acre and 12,360 (8·6%) were lost from the following causes: cultivations 38%, disease 4%, wireworm 7%, flea beetle 7%, birds 30%, mammals 4%, unknown 10%. After singling, the mean population was 31,750 plants/acre. The greatest loss recorded was at Broom's Barn, where 158,200 seedlings emerged but 40,850 (26%) were lost, mainly from close-steerage hoeing in dry weather on stony soil; even so, the final plant population was 34,000/acre.

The losses observed in 1963 and 1964 were of little practical consequence because sowing 4·6 lb seed/acre in 1963 and 5·6 lb in 1964 produced more than enough seedlings. (Dunning)

Fungicide seed treatment. In 17 replicated field trials ethyl mercuric phosphate (EMP) applied to dried seed at 1% vol/wt in the "Mist-o-Matic" machine gave 32% more seedlings per yard and 11% more plants in the final stand than untreated seed, compared with increases of 28%, 31% and 33% seedlings per yard, and 12%, 12% and 13% plants per chain given respectively by EMP steep, an organo-mercury dust and "Mist-o-

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Matic" EMP-treated seed, dried after treatment. Menazon seed dressing increased seedling emergence by 7% and final plant population by 2%, compared with untreated seed.

In small-scale trials the organo-mercury dust used in the field trials gave 34% and 37% more seedlings than two other standard organo-mercury dusts. However, it gave 1% fewer seedlings than EMP steep and 4% fewer than the "Mist-o-Matic" EMP. The most effective treatment in these tests was methyl arsine sulphide, which gave the same total number of seedlings as "Mist-o-Matic" EMP, but 6% more were free from fungal lesions. (Byford)

Wireworm control. The restrictions placed on the use of some organochlorine insecticides have made it necessary to seek alternative materials to protect seedlings from pests. Trials on two wireworm-infested sites tested various formulations.

At Witchford, Ely, where oats failed in 1963 on land ploughed from rough grass in January, the wireworm population on 8 April 1964 was 212,500/acre (all over 5 mm). On 6 April gamma-BHC suspension (8 oz a.i./acre) was sprayed on the ploughed land of the appropriate plots and the trial area immediately cultivated and harrowed. After preparing the seedbed on 8 April the trial was sown with a Stanhay drill, spacing the Sharpe's E $\frac{8}{64}$–$\frac{10}{64}$ seeds $1\frac{1}{2}$ in. apart. Where used, granular insecticide was ducted into the furrow with the seed.

Ten treatments were tested. The gamma-BHC seed dressing was of an unsuitable formulation, and the usual rate of dressing (0·18 oz a.i./acre) had no effect; at five times the usual rate the final plant population was increased. Granules of diazinon (5% w/w at 3·5 oz a.i./acre) and thionazin (10% w/w at 3·5 oz a.i./acre) were also ineffective. Other treatments produced the following numbers of seedlings/yd (mean of counts on 28 April, 7 and 14 May), plants per chain (mean of counts on 26 May and 14 June) and cwt/acre of sugar at harvest on 23 September: control 7·2, 43·1 and 47·3; dieldrin seed dressing (0·17 oz a.i./acre) 10·7, 71·5 and 52·8; dieldrin seed dressing (0·84 oz a.i./acre) 13·5, 73·9 and 56·2; gamma-BHC spray (8 oz a.i./acre) 18·7, 83·3 and 60·9; dieldrin granules (5% w/w at 4·6 oz a.i./acre) 11·4, 70·6 and 56·5; and Bayer 5299 granules (2·5% w/w at 3·7 oz a.i./acre) 12·2, 71·9 and 55·4. Despite the light infestation of wireworms, many plants on the control plots were damaged and the stand of plants was thin. Dieldrin seed dressing at the usual rate gave an adequate plant population, but the best results were with gamma-BHC spray.

At Milton Ferry, near Peterborough, the silty-loam soil contained 500,000 wireworms/acre (412,500 over 5 mm) on 5 May, the date of drilling. Treatments were the same as at Witchford. Wireworms caused no obvious damage, possibly because drilling was late, but all treatments except the usual rate of gamma-BHC seed dressing increased seedling populations on 28 May. Final plant populations were increased by some treatments. (Dunning and Winder)

Docking disorder. Again in 1964, beet grew poorly and were stunted in many fields of very light land during May and June. In occasional fields

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the affected patches were sharply defined and the tap-roots stunted, but in most the affected areas were more diffuse; the plants, even when much stunted, had apparently normal-shaped tap-roots, but the fibrous roots were dead and as new ones developed they, too, were killed. Affected crops recovered strikingly in late July and August and crops that in June looked like failing yielded reasonably. This trouble occurs sporadically and caused concern in 1948, 1949, 1953, 1954, 1958 and 1959, in addition to the last 3 years. Barley crops are often poor in fields where sugar beet are affected.

Fieldmen reported on 137 sugar beet crops suffering from Docking disorder, mostly in the Bury St. Edmunds, King's Lynn, Wissington and Ipswich factory areas. About 1,200 acres were severely affected, and slightly affected crops were common. Plant and soil samples were received from 87 sites, in 19 of which the stunting was probably caused by soil acidity.

The nematode-transmitted tobacco rattle virus (TRV) was isolated from 8 sites and tomato blackring virus (TBRV) from 3; no virus was isolated from the others. Many plants infected with TRV were brightly mottled in spring and early summer, but symptoms faded and the plants looked healthy in late summer and autumn. Plants with symptoms in August yielded at that time only 64% of the weight of tops of their neighbours in the bad patches and 29% of the top weight of more distant healthy beet. Root weights were respectively 52% and 21%. TBRV was less prevalent than in 1963.

Most of the stunted plants seem not to be virus-infected. The trouble at many of the sites is thought to be caused by free-living nematodes feeding on the roots. Work on the eelworms in these fields is reported by the Nematology department (see p. 146).

Many of the affected sites were photographed from the air by Mr. G. H. Brenchley of the National Agricultural Advisory Service. Docking disorder occurs mainly on thin soils of glacial origin overlying chalk and the air photographs show striking patterns of crop growth differences arising from soil profile differences. Further work aims to show the relative importance of soil profile, biological and agricultural factors in producing Docking disorder.

In 1964, in fields at Hopton and Swaffham, where Docking disorder was severe in 1963, the growth of beet was little influenced by seed dressings, by applying granular insecticides and nematicides at drilling, by varying time of ploughing or drilling depth, or by pre-emergence weedkillers; by contrast, the soil fumigants chloropicrin, "D.D.", methyl bromide and dazomet more than doubled the yield of beet; PCNB depressed yield. Seed treatment and granules in the seed drills had no effect in Washpit Breck at Docking. On light soil at Broom's Barn, where no Docking disorder was expected, "D.D." slightly increased, and PCNB decreased, sugar beet yield and phorate and thionazin had no effect. (Heathcote)

Downy mildew. Downy mildew was prevalent in the seed-growing areas of south Lincolnshire and west Norfolk during July and August. At the end of July the fieldmen there reported over 10% of their total acreage

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with more than 1% infected plants, while the similar Ely area with no seed crops had no root crop with over 1%. In the seed-growing area north of Wisbech on 28 July, 15 sugar-beet root crops averaged 16·9% plants with downy mildew compared with 0·67% for the whole Spalding factory area at this time.

At Broom's Barn downy mildew was prevalent on the seed crop. On 27 April the plots sown in summer with no cover crop had 19·6% infected plants; with mustard cover, 13·8%; sown in spring with barley cover, 3·6%. The disease spread to the sugar-beet crops on the farm where 4 sprays with maneb decreased incidence on 20 July from 17·5 to 5%, but did not increase yield. Its spread to an experiment containing Sharpe's E and the yellows-tolerant variety TN 59/5 allowed the susceptibility of the two varieties to be compared: on 23 July 11% of Sharpe's E plants had downy mildew and 38% of TN 59/5. At Terrington, Norfolk, these two varieties also differed; 12% and 29% of plants had mildew respectively on 12 August, but when inoculated in the glasshouse at the seedling stage they were equally susceptible, for Sharpe's E had 53% and TN 59/5 had 56% of plants infected.

A root crop adjacent to the seed crop at Broom's Barn was examined regularly through the season, newly infected plants were marked and the appearance of previously infected plants was recorded. Plants infected before 10 July yielded least sugar in October, but sugar content and juice purity were least in plants becoming infected in the second half of July. Many plants that recovered from the disease became infected a second time.

Seedlings in the glasshouse were inoculated by placing a drop of spore suspension in the growing point, and keeping them in a moist chamber at about 9° C for 24 hours. Up to 60% of plants became infected. When inoculated later than 30 days after sowing, fewer plants became infected than when inoculated younger. Plants could be infected 7 weeks after sowing provided the spore suspension was placed deep in the growing point. When plants were removed from the moist chamber, and the spore suspension dried off 8–10 hours after inoculation, almost as many became infected as when incubated for 24 hours, but fewer did so with only 6 hours in the moist chamber, and infections were rare with shorter times. Spores taken from sugar beet infected red beet and spinach beet, but not spinach; spores from spinach infected spinach but not sugar beet, red beet or spinach beet. Spores from neither beet nor spinach infected *Chenopodium album* or *C. amaranticolor*.

Powdery mildew. This disease was prevalent at Broom's Barn in August and September, and its incidence differed on the plots of several experiments. Early sown plots looked greyer than late sown. Varieties showed increased susceptibility in the order VT 39 and VT 40, MSA, MSB, Sharpe's E and Sh/21/10; the last was so severely infected that many of its leaves were killed. Infection was also prevalent in plots sprayed with insecticides; particularly those sprayed with mevinphos on 5 June. Some interaction with the weather at this time was presumably responsible, for spraying with mevinphos on 28 May, 8 June and 19 June did not increase

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powdery mildew, nor did spraying with demeton methyl on 25 June. (Byford)

Sugar-beet Seed Crops

Four methods of growing seed were compared at Broom's Barn: spring sowing under barley cover with the cover removed in August or September; sowing under mustard cover in July or August; transplanting in December or March from a steckling bed; sowing in July or August without a cover crop. The stand established under barley was thinner than under mustard or without a cover crop. Some transplanted stecklings died, particularly in the December planting, and game attacked the plants during the winter.

Crops sown in spring under barley ripened earliest, those with the cover removed in August before those with cover removed in September. July sowings, both under mustard and without cover, ripened earlier than August sowings. Transplants ripened unevenly. Birds damaged the crop before cutting and while on the tripods.

Yields of clean seed ranged from 13·6 cwt/acre from the transplants to 17·2 cwt/acre from the crop grown under barley. July sowings, both under mustard and without cover, yielded as much as the crop grown under barley, but August sowings, which were much damaged by birds, yielded 25% less. In general, seed-cluster size was inversely related to plant density; the dense stands from the summer sowings produced smaller seed than the thinner stands of plants grown under barley, and the transplanted crop produced the largest seed.

Seed yields were not related to yields of straw; the transplanted crop yielded least seed and straw, but August sowing in the open and under mustard produced more straw than July sowings, and spring sowings under barley yielded less straw than either July or August sowings. Thus, whereas weight of straw increased with increasing plant density, weight of seed did not, because dense stands produced smaller clusters. Large dressings of fertiliser given in the first year gave slightly increased straw but not seed.

Experiments on light sand, at Gleadthorpe Experimental Husbandry Farm, and on loamy clay with flint over chalk, at Bridgets Experimental Husbandry Farm, compared sowings in July and August, with rows 10 in. and 20 in. apart. At Gleadthorpe sowing was later than planned because of a delay in lifting early potatoes. It tested two levels of nitrogen applied in the second year, when the crop was irrigated in June and July. Yields of clean seed ranged from 17 to 24 cwt/acre; they were unaffected by sowing date but increased by about 15% by narrow rows and nitrogen.

In contrast with the results at Gleadthorpe, early sowing at Bridgets gave a larger yield than late sowing; the late-sown plots always seemed under-nourished. The treatments had little effect on seed size at either place, but the seed from Bridgets was much smaller than from Gleadthorpe. However, the varieties were different, Battles E at Gleadthorpe and Bush E at Bridgets. Plants drilled in July in narrow rows at Bridgets produced 27 cwt/acre of seed, the most obtained in this series of experiments. (Scott)

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Sugar-beet Manuring

The results reported are those of trials done in co-operation with the British Sugar Corporation in 1963, for few results of the 1964 trials are yet known.

Magnesium. The treatments in these factorial trials were 0·5, 1·0 and 1·5 cwt/acre N as ammonium sulphate, 0 and 2·5 cwt/acre K_2O as potassium sulphate, 0 and 1·2 cwt/acre Na as sodium sulphate and 0 and 0·9 cwt/acre Mg as kieserite. The six trials in 1963 made the total 14 for the 3-year series. The mean response to magnesium in 1963 was 2·7 cwt/acre sugar, and for the series 3·5 cwt/acre. The dressing of magnesium paid in 9 of the 14 trials; all the sites were selected by fieldmen as likely to have crops showing magnesium deficiency. The 1·5 cwt/acre N was justified in 1963, but over the whole series the best dressing was about 1·2 cwt/acre N.

In 1963 the trials gave differing interactions of magnesium with sodium; on average, these were negative, but positive in the trials that gave most response to magnesium. Magnesium and nitrogen interacted negatively every year, more so for yields of tops than of sugar, an effect apparent in the more vigorous appearance of magnesium-deficient crops given nitrogen. However, nitrogen had little effect on the numbers of plants showing symptoms, whereas magnesium dressings prevented or decreased symptoms everywhere. The percentage of plants showing symptoms on plots without magnesium was not closely related to yield response to magnesium fertilisers. Sodium interacted with nitrogen positively and with potassium negatively, as usual.

TABLE 2

Results of 14 field trials with magnesium in 1961–63

(*a*) Mean yields, averaged over all other treatments

	N_1	N_2	N_3	K_0	K_1	Na_0	Na_1	Mg_0	Mg_1
Clean beet, tons/acre	13·4	14·7	15·3	14·1	14·9	13·9	15·0	14·0	14·9
Sugar, %	17·1	16·9	16·5	16·7	16·9	16·8	16·9	16·7	17·0
Sugar, cwt/acre	45·9	49·6	50·7	47·2	50·4	46·8	50·7	47·0	50·5

(*b*) Two-way table for effects of nitrogen and magnesium on yield

	Roots (tons/acre)			Sugar (cwt/acre)			Tops (tons/acre)		
	N_1	N_2	N_3	N_1	N_2	N_3	N_1	N_2	N_3
Mg_0	12·6	14·4	14·9	43·5	48·3	49·2	8·0	9·8	11·5
Mg_1	14·1	15·0	15·7	48·3	50·9	52·3	8·7	9·8	11·4

Straight versus compound fertiliser. These five trials tested straight fertiliser (ammonium sulphate, superphosphate and muriate of potash) at two rates against "Shell No. 1", "I.C.I. No. 4" and "Chilean Potash Nitrate" with superphosphate. On average, "Shell No. 1" and "I.C.I. No. 4" gave 2 cwt/acre more sugar than the equivalent heavy rate of straight fertiliser. "Chilean Potash Nitrate" proved better than "I.C.I. No. 4" or straight fertilisers at the lesser rate, mainly because of its large good effect a Cupar in Scotland. Nitrate and ammonium forms of nitrogen will be compared again in this area. The difference in yield from straight and compound fertilisers is not consistent, because "straights" proved best in

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the previous 2 years. On average, over 3 years straight fertilisers gave 0·6 cwt/acre more sugar than compound fertilisers.

NPKNa–dung. These factorial trials tested 0·6 and 1·2 cwt/acre N, 0·3 and 1·0 cwt/acre P_2O_5, 0·5 and 2·4 cwt/acre K_2O and nil and 4 cwt/acre salt, all in presence of dung. Five were made in 1961, 3 in 1962 and 5 in 1963 to complete the series. Their main purpose was to test the effect of sodium and its interactions, in presence of dung, because it was not included in the earlier NPK–dung series. The use of sodium was very profitable, but the large dressings of N, P and K rarely paid (Table 3). The sodium–nitrogen interaction, which in all previous series of trials with these elements has been positive, was mostly negative. The reason is not known, and further trials will test the effect of sodium and dung together on nitrogen requirement.

TABLE 3

Results of 13 trials in 1961–63 testing response to N, P, K *and* Na *in the presence of dung*

(*a*) Mean yields, averaged over all other treatments

	N_1	N_2	P_1	P_2	K_1	K_2	Na_0	Na_1
Clean beet, tons/acre	15·9	16·5	16·1	16·3	16·1	16·2	15·9	16·5
Sugar, %	17·0	16·7	16·9	16·9	16·9	16·9	16·8	17·0
Sugar, cwt/acre	54·2	55·0	54·3	54·9	54·2	55·0	53·4	55·8

(*b*) Two-way tables for effects of nitrogen and sodium, and potassium and sodium, on yield of sugar (cwt/acre)

	N_1	N_2	K_1	K_2
Na_0	52·6	54·2	52·7	54·1
Na_1	55·9	55·8	55·3	55·9

NPKNa on Black Fen. This new series of trials was designed to check recommendations for fertilising sugar beet on peat fen, which have little experimental basis. The factorial design included 0, 0·4 and 0·8 cwt/acre N, 0·5, 1·0 and 1·5 cwt/acre P_2O_5, 1·0, 2·0 and 3·0 cwt/acre K_2O and 0 and 3 cwt/acre salt. Seven trials were completed in 1963. On average, the best profit was got without N and with the lowest rates of P and K, but the use of salt was justified. One trial gave a worthwhile response to nitrogen, and one to potassium. These results do not support current recommendations. The treatments were changed for the 1964 trials to include plots given neither phosphate nor potassium.

Residual nitrogen. Three trials were done at the National Institute of Agricultural Engineering, Silsoe, Beds, in 1960–63, each lasting 2 years. In the first year the plots carried barley (0·5 cwt/acre N) or potatoes (0·5 and 1·5 cwt/acre N); in the second year sugar beet, with each plot split for 0, 0·6 and 1·2 cwt/acre N.

Sugar yield was less with the 1·2 cwt/acre N after potatoes given 1·5 than after potatoes given 0·5 cwt/acre N. Sugar percentage and juice purity were consistently greater after barley than after potatoes; beet after potatoes given 1·5 cwt/acre N had the smallest sugar content and most impurities. The response curve to nitrogen after barley was more sharply peaked than after potatoes, and more detailed experiments would be

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TABLE 4

Mean yields of sugar beet after barley or potatoes at Silsoe in 1961–63

Treatment (1st year)	Potatoes 0·5 N cwt/acre N				Potatoes 1·5 N cwt/acre N				Barley 0·5 N cwt/acre N			
Sugar beet (2nd year)	0	0·6	1·2	Mean	0	0·6	1·2	Mean	0	0·6	1·2	Mean
Roots, tons/acre	19·5	20·4	21·3	20·4	19·7	20·8	20·6	20·4	17·3	20·3	20·2	19·3
Sugar, %	16·5	16·6	16·1	16·4	16·4	16·2	15·8	16·1	17·2	17·0	16·6	16·9
Sugar, cwt/acre	64·4	67·7	68·6	66·9	64·5	67·3	65·3	65·7	59·6	68·9	66·9	65·1

needed to measure maximum yields. Clearly, the soil supplied more nitrogen after potatoes than after barley, but the effects cannot be explained simply by regarding this as equivalent to an extra supply of fertiliser nitrogen. (Tinker)

Nitrogen requirement prediction. Methods of testing for available nitrogen in soil were calibrated on 18 trials in 1963. The treatments were 0, 0·45, 0·90, 1·35 and 1·8 cwt/acre N. The greatest yield of roots and sugar were given by 1·8 cwt/acre N, an unusually large amount. However, 0·9 cwt/acre N gave the greatest profit. Nitrogen dressings decreased sugar percentage much less than usual. Soil samples from the trials were incubated to measure mineralisation of nitrogen, and tested for barium-hydroxide-extractable "glucose" (*Rothamsted Report* for 1963, p. 55). None of the analytical methods gave results that correlated well with the amount of nitrogen giving the greatest yield, but different fields gave widely different yield responses to N, and those giving the greatest can often be predicted.

The poor correlations may in part be caused by the ratios of mineral nitrogen produced or stored in top- and sub-soil differing in different fields. The ratio ranged from 1·14 to 3·5 for mineral N present after incubation in air-dried soils sampled during spring. The $Ba(OH)_2$-extractable "glucose" correlated well with mineral nitrogen produced during incubation ($r = +0{\cdot}82$) and with mineral N present after incubation ($r = +0{\cdot}83$).

The relationship of leaf and petiole nitrate to yield response to nitrogen was also studied using crops at Broom's Barn in 1963. Nitrate was measured in dried leaves by Ulrich's method (*Bull. Calif. agric. Exp. Stn.*, 766), and in a macerate of wet tissue, by reducing nitrate with titanous sulphate. Petiole nitrate varied consistently with the amounts of nitrogen fertiliser applied to the seedbed as a top dressing, and its concentration decreased with time. In 1964 similar determinations were made on plants from 10 field trials sampled in the second half of June, and from a trial at Broom's Barn sampled four times during the summer. Petiole nitrate varied consistently with nitrogen dressing within each trial and with time at Broom's Barn, but over all trials there was no consistent relationship between nitrate content and optimum N dressing. The method seems unlikely to be of practical use for advising on the need to top dress with N. Top dressings had no effect on petiole nitrate content in four trials sampled in August, except at Broom's Barn, where the crop was irrigated. (Tinker)

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Broom's Barn Farm

An implement shed with a lock-up tractor bay and workshop was erected to the north of the farm buildings.

This year was our fifth harvest, and most fields have had a complete rotation of crops. Our object so far has been to improve the yield and uniformity of crops, decrease the weed infestation and get the land into a good state for field experiments. The five fields at the north end of the farm with lighter soil (Black House, Brome Pin, Dunholme, Flint Ridge and Marl Pit) are cropped with barley, silage, wheat, barley and sugar beet in turn. The four with heavier soil (Little Lane, Bull Rush, White Patch and Hackthorn) are cropped with barley, silage, wheat and sugar beet. The silage crop is oats and tares or Italian ryegrass.

Winter wheat receives 90, 38 and 38 units of N, P and K, respectively. Barley receives 60, 30, 30, sugar beet 96, 54, 54 plus 3 cwt/acre of salt or 6 cwt of kainit and the silage crop 130, 31, 31 units. Over the 5 years fields have had an average annual dressing of 50–90 units of N, 30–40 of K excluding kainit, and of P. Farmyard manure is usually applied after the silage crop. Fields where the pH falls below 6·5 in patches receive 3–4 tons/acre of limestone, with heavier dressings on the sour areas. Only the light soil at the north of the farm has needed lime. Water is given to the grass and sugar beet when the weather justifies it, but we have too few workers to use the irrigation plant to full advantage.

The deepest ploughing is 10 in., because below this some fields have many stones. Each field is cultivated at least 14 in. deep during the summer every four or five years. After the silage crop the land is worked several times during the summer and levelled with the land-plane. All straw is removed in bales and the stubbles cultivated during the autumn. Weeds are killed whenever possible by cultivation or chemicals. Wild oats and broad-leaved weeds are now fewer, but some fields are still infested. The fields now have a more uniform colour when ploughed, and chalk and gravelly patches are less obvious than they were. Crop yields have increased; barley from 20 and 17 cwt/acre in 1960 and 1961 to 40 cwt/acre this year; wheat from 22 cwt/acre in 1961 to 43 cwt/acre; sugar beet from 13½ tons/acre at 15·5% sugar (2·09 tons/acre of sugar) to 14½ tons at 18·3% sugar (2·64 tons/acre of sugar). The uniform crops we are growing give accurate field experiments. This year the plot errors in barley experiments are 2·6 and 4·1%; in a wheat experiment 3·6%; for root yield on 10 sugar-beet experiments from 2·0 to 8·4%, average 4·3%.

The plot error for a wheat experiment on White Patch field was 12·6%. This field has grown grass for seed for several years and has not had the thorough cultivations given to the other fields. The sward was shallow-ploughed in the autumn of 1963 and sown with winter wheat. Ploughing 10 in. deep in the autumn of 1964 showed the reason for the variable crop and big plot error, for the soil at this depth is very variable.

Cereals. Harvest lasted from 6 to 28 August, with the corn coming from the combine at 13–15% moisture. The winter wheat var. Cappelle on Marl Pit, White Patch and the Holt yielded respectively 41, 44 and 43 cwt/acre

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of grain and 116 bales/acre of straw. Barley var. Pallas yielded 43 cwt/acre on both Black House and Bull Rush, with 80 and 92 bales/acre of straw, but on Brome Pin, where mildew and lodging were more prevalent, yielded only 34 cwt/acre of grain and 70 bales/acre of straw. Both cereals were sprayed in spring with TBA plus MCPA and all the barley with barban, but only patches of the wheat. During the summer wild oats were few in the barley, but wheat was infested in places.

On Brome Pin F. V. Widdowson tested the effect of different forms of nitrogen: nil, 45 and 90 units/acre N gave 33·8, 38·9 and 42·5 cwt/acre of barley grain respectively.

The effect of spraying winter wheat, var. Cappelle, on 24 April with a proprietary formulation of TBA plus MCPA at 1, 2 and 3 times the normal dosage was determined on White Patch field. All the sprays controlled weeds well, but even on the unsprayed plots weeds did not seriously compete with the wheat. The stronger sprays stunted the wheat and gave shrivelled grain, which did not ripen. The plots were harvested on 28 August, and the yields for the untreated control and the three dosages of spray respectively were 44·3, 36·5, 26·4 and 17·4 cwt/acre of grain. The experiment will be cropped with sugar beet in 1965 to detect any residual effects of the chemicals.

Sugar beet. Sowing started on 13 March in Dunholme field, where most experiments were situated. Weather delayed drilling in late March, and most of the crop was sown in mid-April. The seedbed on Little Lane was poor in places as a result of the drainage work during the early winter. Sowing here was from 10 to 27 April, using precision drills sowing rubbed and graded seed at 1½ in. spacing. All was band-sprayed with "Murbetex" pre-emergence weedkiller, which did not control weeds so well this year as last. In experiments run by Mr. G. Cussons of Norfolk Agricultural Station, two new herbicides, "PCA" and "Dupont 634", controlled the large weed infestation on Dunholme, which comprised 25 species, and gave clean brairds of vigorous sugar beet seedlings.

Little Lane had 1½ in. of water applied on 17–22 July and 1½ in. in early August. The experiments in Dunholme had 1½ in. of water on 6–11 August and again on 25–31 August. The pipes were moved 30 ft instead of 60 ft, with an intermediate starting-point for the second watering to give a more uniform water distribution.

Dunholme field was sprayed on 16 June and 17 July with systemic insecticide, and Little Lane on 26 June to control a light infestation of green aphids.

The crop on Little Lane developed slowly and was attacked by downy mildew, which spread from the beet seed crop in the Holt. Yields on experiments on Little Lane were approximately 13 tons/acre of roots and on Dunholme between 15 and 19 tons/acre. Harvesting started in mid-September, when the soil was so dry it had to be watered to allow progress, and finished on 15 December. The average yield delivered to the sugar factory was 14·46 tons/acre with sugar contents ranging from 20·3 to 16·9%, average 18·3%, and dirt and top tares averaged 11·6 lb/cwt. The country's average yield this year was 14·5 tons/acre of roots at 17·7% sugar.

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On average, sugar beet gives small responses to N on the farm. In 1963 on the light soil, increasing the N from 0·3 to 1·2 cwt/acre increased yield by 15 cwt/acre of sugar, but neither farmyard manure nor complete fertiliser gave consistent responses on the heavier soil. In 1964 the responses in adjacent trials on the light soil were 5 and 7 cwt/acre of sugar, and 0·5 and 1·0 cwt/acre N gave the largest yield. Both trials yielded over 60 cwt/acre of sugar on plots without N.

Salt and potash gave mean responses of 7 and 4 cwt/acre of sugar respectively in 1963, and magnesium increased yield by 2 cwt/acre also. The light soil contains little potassium; although magnesium content is also small, it is more than in most fields where sugar beet shows deficiency symptoms.

Time of sowing and harvesting. Cold, wet weather in the spring delayed the growth of the first sowing in mid-March, and at harvest 11% of the plants had bolted, compared with ½% in the mid-April sowing. Table 5 gives the sugar yields, sowing and harvesting dates. Twice as many

TABLE 5

Yield of sugar from beet sown and lifted on different dates on Dunholme Field, 1964

	Lifting date									
	21 Sept.		19 Oct.		16 Nov.		7 Dec.		Mean	
Sowing date	cpa	%	cpa	%	cpa	%	cpa	%	cpa	%
13 March	51·9	17·4	65·2	17·7	68·1	18·1	72·2	17·5	64·4	17·7
14 April	56·1	17·2	61·2	18·1	68·2	18·6	67·5	18·3	63·2	18·1
28 April	49·9	17·0	59·7	17·8	57·9	18·0	62·7	18·0	57·5	17·7
Mean	52·7	17·2	62·0	17·9	64·7	18·3	67·5	17·9	61·7	17·8

plants in the third sowing had virus yellows as in the first sowing. Delaying sowing had only a small effect on yield and sugar percentage, but delaying harvesting increased yields. The sugar percentage increased until mid-November and then decreased slightly. The K and Na content of the root juice decreased slightly with later harvesting, but was unaffected by sowing date; in contrast, α-amino-N was unaffected by harvesting date, but was considerably greater in the later-sown beet.

Spacing and time of sowing. The brairds from Bush monogerm seed sown at 2¼-in. spacing on 20-in. rows on 2, 14 and 28 April were singled to give plant populations of approximately 42,000, 25,000 and 16,500 per acre. There were significantly more green aphids per plant at 21 July on the third sowing than on the first and second sowings, and the number was inversely proportional to plant population on the second and third sowings only. There were 0·5 green aphids per plant on the first sowing with 42,000 plants per acre, but 4·5 per plant on the third sowing with 16,500 plants per acre.

Few plants got yellows, but on 15 September the late sowing had most infected plants, especially with the small plant population. The percentage of plants with downy mildew on 28 August was inversely proportional to plant population on all three sowing dates; on all three plant populations

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of the third sowing, incidence was significantly greater than on the equivalent plant populations of the two earlier sowings. Infected plants per acre were equal with the three plant populations on the third sowing, but fewer, and their numbers were inversely proportional to plant population with the two earlier sowings.

Sugar yields on the first, second and third sowings respectively were 54·7, 58·8 and 52·4 cwt/acre; the first sowing probably yielded less than the second because it had 11% of bolters, whereas the second sowing had 5% and the third 1%.

Sugar yields and sugar percentages for the three plant populations in increasing order, averaged over sowing dates, were 53·3, 56·1 and 56·5; 17·9, 18·4, 18·5. Na, K and α-amino-N content of the root extract all tended to be inversely proportional to plant population; late drilling increased the α-amino-N.

Bitumen mulch. In co-operation with the Woodstock Agricultural Research Centre the effect was tested of a layer of bitumen sprayed over the rows behind the seeding unit. The experiment compared nil, 0·1 mm and 0·3 mm thickness of bitumen in a band 5 in. wide on sowings on 2, 14 and 28 April. Temperatures were determined with thermistors set in the soil under the rows. In April the soil under the mulch was about 2° C warmer at noon on a bright day than with no mulch, 1° C when cloudy and about ¼° C at night. In May at 17.00 hours differences under mulch and no mulch of 5° C were measured at 3 in. depth, compared with 3° C at 1 in. depth. The thickness of mulch made no difference. The mulch increased seedling emergence and size of plant at first, but did not affect yield of sugar on any of the drillings. It decreased the percentage of bolters from 18 to 12 on the first drilling. Yields for the first, second and third sowings were 62·4, 60·1 and 57·0 cwt/acre of sugar respectively.

Spacing and variety. Four varieties of seed, Klein E monogerm, Klein Z monogerm, K.W.-Monopolybeta and Hilleshog Special N were sown on 9 April in rows either 20 in. or 10 in. apart. Plants were spaced 10 in. apart in the rows. The rows at 10-in. spacing were in beds of 5 rows, with 20 in. between the beds to take the tractor wheels, and the yields of the inner and outer rows were determined separately. Mean sugar yields from the 10-in. and 20-in. spaced rows were 76·2 and 67·7 cwt/acre. The yield difference between wide and narrow spacings was greater with Klein E and Hilleshog N than the other two varieties; Klein E and Hilleshog N sown at 10-in. spacing yielded over 4 tons/acre of sugar. Row width scarcely affected sugar percentage, but Klein Z and Hilleshog N had about ½% more sugar content than the other varieties. Close rows tended to give fewer juice impurities. Polybeta had 5% of bolters and the other varieties very few. Table 6 gives sugar yields for the whole plots; these differ from the yields given above because the mean row width for the beds is 12 in. when the 20-in. wheelings are included.

Half of each plot was hand lifted and half with a prototype "Catchpole Mono-Cadet" harvester, able to work on the narrow rows because it is mounted to one side of the tractor. Plot standard error, about 5% of the

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mean, was similar for the two lifting methods, but root yield and sugar yield were 1·7 tons/acre and 6 cwt/acre less for the machine-lifted plots. Losses of root yield by machine harvesting were greater with the close than with the wide spacing (1·58 and 2·15 tons/acre respectively), but similar for sugar percentage. Varieties gave very similar root yield differences at the two spacings when machine-harvested.

TABLE 6

Sugar yields from plants at different spacings

Variety	20 in. between rows	10-in. spacing in beds	Mean
	Sugar yield (cwt/acre) (SE ± 1·55)		(±1·09)
Klein E	69·4	72·3	70·9
Klein Z	69·2	70·6	69·9
KW-Polybeta	65·6	67·0	66·3
Hilleshog N	66·6	71·3	68·9
Mean (±0·77)	67·7	70·3	69·0

The beds were 20 in. apart and the rows in the beds at 10-in. spacings. The plant population was 24·1 thousands/acre with the 20-in. spacing and 39·2 in the beds. The beet were harvested by hand.

Growing sugar beet in closer rows has two potential advantages that may be important in helping to obviate the need for hand labour during spring. First, the ground is covered by foliage about 3–4 weeks sooner, so preventing weed growth when herbicides applied to the seedbed are no longer effective. Secondly, a reason for using monogerm seed is to sow to produce the final stand without singling. One of the risks is the loss of seedlings after emergence. Sowing to a stand of 50,000–60,000 plants per acre at narrow spacings would allow up to half the randomly distributed seedlings to be lost and still leave an acceptable stand.

Yellows-tolerant varieties. The yellows-tolerant varieties TN 59/5, VT 39 and VT 40, bred at the Plant Breeding Institute, and two varieties produced by Bush Johnson, MSA and MSB, from yellows-tolerant lines bred at Dunholme, were compared with Sharpe's E. Some plots were kept free from aphids and yellows with insecticides, and others infected with BMYV (contaminated with BYV) on 25 June. The experiment is one of several arranged by the National Institute of Agricultural Botany to test yellows-tolerant varieties. Yellows infection decreased sugar yield on average for all varieties from 58·0 to 38·7 cwt/acre. Without yellows, Sharpe's E yielded 60·5, the PBI varieties 57·6–58·9 and the MS varieties 55·0–57·6 cwt/acre of sugar; with yellows the corresponding yields were 33·4, 37·0–41·7, 39·3–39·8 cwt/acre. On average, tolerant varieties with yellows gave 69% of the yield when healthy, whereas Sharpe's E gave 55%. Yellows decreased the sugar percentage from 17·8 to 16·6 on average, most on Sharpe's E, which it decreased from 18·1 to 16·2.

Irrigation. The rotary overhead sprinklers used for farm irrigation are not suitable for watering small plots in experiments, because they distribute water unevenly and cover a big area. Trials with perforated plastic hoses laid between the sugar-beet rows suggested that small plots could be watered in this way, so a 4 × 4 Latin square experiment was started

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during August, in the valley at the south end of Dunholme field, to compare 1 in. and 2 in. of water at the beginning of August with 2 in. in August followed by 2 in. in mid-September. The sugar beet was sown on 7 April and harvested on 19 November. The watered plots were 10 rows wide, 25 ft long with 10 yd wide discards between them. The soil was at field capacity at the end of April, and the water deficit gradually increased until it was 9½ in. in mid-September. Even with the 3·2 in. of rain in June the soil-water deficit increased from 2 to 3½ in. less than field capacity. The 2-in. watering in August left the soil 3½ in. less than field capacity and 1¼ in. less than the planned deficit. The September watering left corresponding deficits of 4½ in. and 1¾ in., and these plots reached the planned deficit by mid-November.

Yields without watering, and with 1, 2 and 4 in. of water were, respectively, 16·09, 17·11, 17·26 and 17·60 tons/acre of roots; 18·3, 18·2, 18·4 and 17·9% sugar content and 58·8, 62·3, 63·6 and 63·1 cwt/acre of sugar. The standard error per plot for sugar yield was 2·4% of the mean. This method of watering experiments seemed to work satisfactorily, and we plan to develop it further in 1965.

Subsoiling. The yield responses to subsoiling in August 1961 on Little Lane field were again positive but smaller than in 1963. Subsoiling increased sugar yield by 1·7 cwt/acre, barley and wheat by 0·2 and 0·7 cwt/acre of grain respectively, and the first cut of lucerne by 0·2 cwt/acre of dry matter. Yields with smaller and larger dressings of fertilisers than recommended ones were 49·6 and 47·5 cwt/acre of sugar, 36·3 and 37·3 cwt/acre of barley, 41·1 and 47·8 cwt/acre of wheat and 39·3 and 41·0 cwt/acre of lucerne. Each year extra fertiliser has given little extra yield of lucerne and barley and has decreased sugar yield; the wheat response is greater this year than previously.

Grass and miscellaneous crops. The Italian ryegrass on Flint Ridge yielded 6 tons/acre of silage in June, and after 1½ in. of irrigation water about 1 ton/acre of hay. Windbreak also gave cuts for silage and hay. Oats and tares on Hackthorn yielded 5 tons/acre of silage.

Carrots on 1 acre of Dunholme, grown for Marion A. Watson in beds of 5 × 10-in. rows with 20-in. tractor wheelings, became infested with *Cavariella aegopodii* in May, but these did not spread viruses extensively. Granular menazon drilled below the seed depressed yield of ungraded carrots by 17% at the end of September and from 39 to 37 tons/acre in December.

Kale on ½ acre on Dunholme yielded 3 cwt of seed.

Livestock. The 76 Hereford-cross cattle bought in the autumn of 1963 gained an average of 1·76 lb per beast per day in liveweight during a period of 114–224 days in the yard. They were sold during March, April and May, when 74 made A grade and 2 B grade. In the autumn, 61 Hereford-cross single-suckled calves, and 20 Hereford–Friesian cross, weighing on average 4·9 cwt and 4·4 cwt respectively were bought. They are being fed on silage, hay and barley with a protein supplement.

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Weather Records

With the help of the Meteorological Office a weather station has been set up 38 yards to the south of the main building to record each day the rainfall, sunshine, air and earth temperatures. Table 7 gives measurements for 1964 and compares them with long-term averages for Mildenhall, 6½ miles N.N.W. of Broom's Barn, kindly supplied by the Meteorological Office.

TABLE 7

Long-term mean weather at Mildenhall and in 1964 at Broom's Barn

	Long term means for Mildenhall (Suffolk)			Broom's Barn 1964		
	Mean temp. 1936–60 (° F)	Mean daily sunshine 1936–60 (h)	Mean rainfall 1916–50 (in.)	Mean temp. (° F)	Mean daily sunshine (h)	Mean rainfall (in.)
Jan.	38·1	1·70	1·90	39·5	Not recorded	0·90
Feb.	39·0	2·51	1·41	43·4	,,	0·96
March	43·3	4·00	1·25	42·5	,,	2·13
April	47·8	5·36	1·71	52·9	,,	2·10
May	53·4	6·50	1·62	67·4	7·44	1·09
June	59·0	7·04	1·49	64·8	5·56	3·20
July	62·2	6·24	2·42	70·8	6·34	1·06
Aug.	62·1	5·96	2·03	70·3	6·39	1·18
Sept.	58·1	4·71	2·01	68·2	6·76	0·54
Oct.	51·3	3·46	1·92	54·6	4·04	1·28
Nov.	44·6	1·88	2·05	50·5	2·21	1·85
Dec.	40·5	1·42	1·80	42·7	1·46	1·80
Year	50·0	4·24	21·61	55·6	—	18·09

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