Report for 1971

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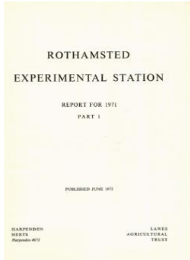

Broom's Barn Experimental Station

R. Hull

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BROOM'S BARN EXPERIMENTAL STATION

R. HULL

The sugar-beet grower can influence the yield of his crop more by sowing early than by any other factor he is likely to control, so much of our work investigates problems of establishing crops early. The risk of damage from pests and diseases is greater when seedlings grow slowly from early sowings, so more effective controls are needed. Spreading fertiliser in the spring and working the soil to produce a seed-bed not only delay sowing but compact the soil, and this restricts growth of sugar beet. Consequently we investigate different times and methods of applying fertiliser and methods of growing the crop that allow it to be sown with the least disturbance and compaction of the soil. The acceptable limits of plant density and distribution need defining for different sowing times and the extent to which they are influenced by nutrition, variety and the water available to the crop. Reliable seedling emergence is needed if the desired plant stand is to be established with little or no hand-work and our investigations of seed production and preparation have this objective.

The country's record yield in 1971 of more than 7½ million tons of sugar beet is doubtless largely due to 85% of the crop acreage being sown by 10 April, compared with 20% by that date in 1970 when the yield was 6⅓ million tons. There were hot and dry periods in both growing seasons and they had almost the same total sunshine hours. In 1970, however, May and June were dry whereas in 1971 rain returned the soil to field capacity in June. The growing conditions of 1971 resulted in sugar beet at Broom's Barn rooting below 160 cm deep, and although the soil moisture deficit reached 150 mm later in the summer, the plants were able to draw moisture from the subsoil and responded little to irrigation. The unirrigated crop did not wilt and grew rapidly in the hot bright weather during the summer. With a similar maximum soil moisture deficit in 1970, irrigation was needed to give a full yield from the shallower rooted plants. Crop yields seem to be closely related to the rate of root extension and depth of rooting, and we need more information about the factors influencing them.

Seedling pests and diseases

Fieldmen of the British Sugar Corporation reported that mice and birds caused far more damage than invertebrate pests to sugar-beet seedlings. Skylarks were blamed most frequently for defoliating seedlings, sometimes so severely as to kill them; about 400 ha of beet failed and 45 000 ha were damaged by small birds. Significant damage from field mice has not previously been noticed, but this year they took ungerminated seed, damaging 6100 ha of sugar beet and 60 ha failed. The damage by both these pests was accentuated by slow germination and growth of the early sown crop, and because much of it was sown with monogerm seed at wide spacing. (Dunning)

Pitfall trapping. The extent of the leaf canopy may influence pitfall trap catches of epigeic fauna; a trial at Broom's Barn compared plots with bare soil, one-third cover (two-thirds of the beet plants removed) and full cover (75 000 plants/ha), the last without insecticide or with 1·12 kg γ-BHC/ha worked into the seedbed, 1·12 kg DDT sprayed on 26 May and 0·28 kg demeton-S-methyl sprayed on 30 June. Plots were 15 × 10 m, in a Latin Square design, with two pitfall traps (*Rothamsted Report for 1969*, Part 1,

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312) 5·5 m apart near the centre of each plot. *Bembidion lampros*, a carabid beetle was most numerous during May and June, and traps on the one-third cover and bare plots caught most. In contrast most *Feronia melanaria*, another carabid, were caught on the full-cover plots and fewer with decreasing plant cover; this ground beetle was most commonly caught during June (up to 112/trap) and August. Most staphylinid beetles were trapped on the bare or one-third cover plots early in the season but cover did not affect the numbers caught after July. The traps in the bare plots similarly collected most aphids and coccinellids (adults and larvae) but fewer pygmy beetles (*Atomaria linearis*) than in the plots with beet. Fewer creatures (except aphids) were trapped on plots with insecticide, especially early in the season; only half as many beetles were caught on the treated as on the untreated plots.

The epigeic fauna in sugar-beet crops on five soils (silt, peat, clay, chalk, sand) were compared with pitfall traps placed near the headland and near the centre of each field; the trapping period was as in 1970 but there were six traps per site. Most pygmy mangold beetles were caught on the silt and peat, especially during May and July. Shortly after singling, the roots at the peat site were severely damaged by pigmy beetle but not at the sand site, where the beetles were fewest. The beet seedlings grew most vigorously on the silt, despite the damage caused by the many beetles. Fewer millepedes were trapped than in 1970; a few *Brachydesmus superus* were caught during May and June at all sites except the sand, *Polydesmus coriaceus* were trapped only on the clay, and *Brachyiulus pusillus* were only on the peat. Many carabid beetles were trapped; the dominant species at each site were *Amara apricaria* (sand), *Harpalus rufipes* (chalk), *Feronia melanaria* and *Bembidion lampros* (peat), *F. melanaria* and *Agonum dorsale* (silt) and *F. melanaria* and *H. rufipes* (clay). During April and May, as in 1970, the carabids most commonly caught at all sites were *Bembidion* spp., and they were especially numerous on the clay, peat and silt. The significance of these predatory beetles in controlling sugar-beet pests is not known.

Biology. The amount of damage to sugar-beet seedlings by pygmy beetle differs from year to year, probably depending on the time and intensity of migration of the beetles from last year's beet fields in relation to the stage of seedling growth. Sticky traps were used to study aerial migration from mid-April at five sites in East Anglia. Most were flying synchronously at all sites in early May, but the numbers caught at each site differed; none was caught after July. The suction trap at Broom's Barn caught beetles only between 20 April and 13 July, and 60% of the total were caught on 8–10 and 18 May, up to 50/day. The number of beetles caught in pitfall traps in East Anglia reached a second peak in July, although few were flying at this time.

Brachydesmus superus is a sporadic pest of sugar-beet seedlings, and the adults are much more active and potentially dangerous than the young. Populations of this millepede were sampled at intervals in two fields. Adults predominated during April, but first stadia during May, when adults were not caught in pitfall traps and the seedlings were not obviously damaged. By contrast, on the same site (silt) in 1970, most of the population were adults during May; they were frequently caught in pitfall traps, and seedlings were damaged (*Rothamsted Report for 1970*, Part 1, 249). Other observations indicate that development rate differs between years, which would affect their importance as seedling pests. In the laboratory, *Blaniulus guttulatus* aggregated around emerging seedlings and caused typical seedling damage, and there was some evidence that the life cycle includes periods when they do not eat and seedlings could grow unharmed. The distribution of millepedes was surveyed during November to identify the soil types in beet-growing areas most likely to support large populations. (Baker and Dunning)

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Seedling pest numbers, aggregation and factors affecting damage. Soil samples were taken, usually to a depth of 30 cm, to estimate the numbers and distribution of pygmy beetles and millepedes in field soils at Boston, Lincs., Welney, Norfolk (both beet after beet), Bottisham, Cambs., and at Broom's Barn (both beet after cereal). The creatures were extracted by flotation with water and petroleum-spirit, a method especially effective for young and resting stages of all millepedes. At Welney estimated populations of pygmy beetles in January, February and March were 7·2, 4·4 and 5·9 million/ha to a depth of 30 cm; most were in the top 15 cm in January but in the lower 15 cm by the middle of March. There were an estimated 4·9 million beetles/ha in the top 10 cm just before seedlings emerged in late April. Populations of *B. superus* decreased from 8·9 million/ha in January to nil by April, when only eggs were recovered. At Boston, beetles were fewer than at Welney in mid-April, but there were several millepede species, mainly *B. superus*, *B. guttulatus*, *Macrosternodesmus palicola*, *Brachychaeteuma bradeae* and *Isobates* sp. Bottisham was free from pigmy beetles, but had many *B. guttulatus* and *Archeboroiulus pallidus* in February and March, especially very young stages; in mid-April, before seedlings emerged, there were 10 million/ha, a third in the top 10 cm and two-thirds between 10 and 20 cm deep. Broom's Barn was free from millepedes, but had 0·2 million pygmy beetles/ha in mid-April before seedlings emerged; this was before any flying beetles were caught in the suction trap, so they may have been the resident population.

At Broom's Barn, Bottisham and Welney, pelleted Amono monogerm seed, without dieldrin, was sown at 2·5, 7·5 and 23 cm spacing in rows 51 cm apart, and half the plots of each spacing were sprayed with pyrazon herbicide at the rate recommended for the soil type. At all sites increasing the spacing increased seedling numbers expressed as a percentage of the numbers of seeds sown, and decreased seedling dry weight at Broom's Barn and Bottisham (not measured at Welney). Seedlings were fewer and smaller on plots sprayed with pyrazon than in comparable unsprayed plots.

At Broom's Barn in mid-May pygmy beetles averaged 0·8 per soil core (274 cc) centred on a seedling, regardless of the spacing; also, widely spaced seedlings suffered only the same minor damage as closely spaced ones. At harvest, sugar yield was unaffected by any of the treatments. At Welney in late May there were 5·5 beetles/soil core centred on a seedling but only 1·1/soil core between the rows. So many seedlings were killed by the beetles that further observations were not made.

Other trials at Welney and Bottisham tested whether soil compaction affected pest aggregation in the rows. On the uncompacted plots the seedbed was kept as loose as possible and the inter-row space rotovated immediately after sowing; on the compacted plots, tractor wheels firmed every inter-row space and a garden roller firmed the seed rows. These treatments, which increased soil bulk density in the row from 1·1–1·3 to 1·4 g/ml did not affect seedling establishment at either site. At Welney, numbers of pygmy beetles, onychiurid Collembola and mites around seedlings were the same in compacted and uncompacted plots, and only the beetles aggregated markedly around the seedlings—6·7/core around plants *v* 0·2/core between the rows. At Bottisham, more millepedes aggregated around the seedlings in the uncompacted than the compacted plots, but onychiurid Collembola and soil mites did not; all three creatures aggregated partially in the seedling rows but less than the pygmy mangold beetles at Welney. (Baker, Dunning and Winder)

Insecticide applied to seed and soil. Thirteen trials in different sugar-factory areas tested various insecticides incorporated during pelleting of Amono monogerm seed. As in 1970, dieldrin at six rates, from 0·1 to 3·2% by weight of seed, did not affect germination in the laboratory either soon after pelleting or six months later; nor did

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'C 10015' at 0·2, 0·8 or 3·2%. All trials were drilled between 23 March and 8 April, much earlier than in 1970, and seedlings established better. In all trials, seedlings averaged 60% of the numbers of seeds sown, but averages at different sites ranged from 32 to 73%. Treatment effects were small but dieldrin at 0·2% and 0·4% increased seedling and plant numbers; other rates and treatments were ineffective, and 3·2% of 'C 10015', 0·8% of carbaryl and 0·2% of γ-BHC decreased seedling and plant numbers. Wireworms caused damage only at Ely, where all amounts of dieldrin and 0·2% γ-BHC increased seedling and plant numbers.

The same treatments, and also 0·8% propoxur and 0·8% methiocarb in pellets were compared with 1·12 kg/ha γ-BHC worked into the seedbed at Broom's Barn; Bottisham, Cambs.; Welney, Norfolk and Boston, Lincs. At the latter two sites sugar beet was damaged by pygmy beetle in 1970; this year the pests' damage was very severe and only 9% and 27% respectively of the number of untreated seeds sown at these sites produced seedlings. Damage was insignificant at the other two sites, where 54% of the untreated seeds produced a seedling. Gamma-BHC seedbed spray increased seedling numbers at all four sites—by 421% at Welney, 139% at Boston, 7% at Broom's Barn and 20% at Bottisham. Effects of some of the seed treatments on seedling numbers, either increases or decreases at the four sites respectively, were: 0·8% methiocarb 437, 108, −3 and −21%; 0·8% propoxur 76, 59, −7 and −27%; 0·8% carbaryl 88, 64, −17 and −38%; 0·8% 'C 10015' 54, 38, −8 and −27%; 0·8% dieldrin 12, 30, −4 and −8%; 0·2% dieldrin −22, 46, 0, −18%; 0·2% γ-BHC 256, 106, 1 and −5%. All seed treatments decreased seedling numbers at Bottisham; field mice caused damage at this site and the chemicals may have helped them to find the ungerminated seeds.

The trial area at Welney, and part of a field at Magdalen, Norfolk, where many plants were killed by pygmy beetle, millepedes and symphylids, were resown on 18 May and 17 June respectively. At Welney 44% of untreated seeds produced a seedling and γ-BHC spray increased seedling numbers by 98%; 0·2, 0·8 and 3·2% methiocarb seed treatment by 81, 93 and 94%; 0·8 and 3·2% propoxur by 39 and 42%; 0·2, 0·8 and 3·2% carbaryl by 34, 19 and 35%; 0·2, 0·8 and 3·2% 'C 10015' by −19, 13 and 45%; 0·2% γ-BHC by 41%. At Magdalen only 14% of untreated seeds produced a seedling: 'Dupont 1410', methiocarb and γ-BHC at 0·70 kg a.i./ha, as a solution at 370 litres/ha in the seed furrow, increased seedling numbers by 70, 50 and 36% respectively; 0·2, 0·8 and 3·2% methiocarb seed treatment by 84, 52 and 98%; 0·8 and 3·2% propoxur by 90 and 66%; 0·2. 0·8 and 3·2% carbaryl by 28, 107 and 61%; 0·2, 0·8 and 3·2% 'C 10015' by 18, 12 and 20%; 0·2, 0·8 and 3·2% dieldrin by 38, 37 and 40%; 0·2% γ-BHC by 46%.

Further trials at Welney, Boston and Bottisham compared liquid formulations of γ-BHC, carbaryl, 'C 10015', diazinon, 'Dupont 1410', 'Dursban', fenthion, fenitrothion, heptachlor, methiocarb, phoxim and propoxur at 0·07 and 0·70 kg/ha, aldicarb granules at 0·70 kg/ha and dimethoate granules 0·98 kg a.i./ha, all in the furrow with the seed. At Broom's Barn, where pest attack was not expected, the granules and the larger amounts of liquids were tested to assess any adverse effects on plants establishment. 'Cytrolane', mecarphon and fonofos granules, at approximately 0·70 kg a.i./ha were also included at Boston, Welney and Broom's Barn. Seedling numbers were increased mostly by the better treatments where pygmy beetle attacked most strongly, e.g. at Welney, and the adverse effects were greatest at Broom's Barn. At Welney only 7% of the untreated seeds produced a seedling, and the most effective treatments (all at 0·70 kg a.i./ha unless otherwise stated) were: methiocarb solution which increased seedling numbers by 623%; aldicarb, and mecarphon granules (0·91), by 5–600%; γ-BHC, heptachlor, 'Dupont 1410', propoxur, 'C 10015' solutions, and dimethoate granules (0·98) by 4–500%; diazinon solution by 3–400%; and γ-BHC (0·07) and DDT by 2–300%. At Boston 35% of the untreated seeds produced a seedling: γ-BHC (0·07), DDT, hepta-

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chlor (0·07 and 0·70), 'Dupont 1410', methiocarb and diazinon solutions, and mecarphon (0·91) granules, increased seedling numbers by 75–100%; DDT (0·07), 'Dursban' (0·07 and 0·70), fenitrothion, carbaryl, propoxur, methiocarb (0·07), 'C 10015' (0·07) solutions, and aldicarb granules, by 50–75%. At Bottisham 59% of the untreated seeds produced a seedling: DDT, and heptachlor (0·07) solutions increased seedling numbers by 20–26%; γ-BHC (0·07), 'Dupont 1410' (0·07 and 0·70), fenthion (0·07), fenitrothion (0·07), carbaryl and 'C 10015' (0·07 and 0·70) by 10–20%. At Broom's Barn 74% of the untreated seeds produced a seedling and most treatments decreased seedling numbers: fenthion by 92%; dimethoate (0·98) granules, phoxim and 'Dursban' solutions by 45%; fonofos (0·84) granules by 35%; γ-BHC, heptachlor, methiocarb and fenitrothion by 10–20%. Some plants died on the γ-BHC treated plots during June and July. Other treatments decreased numbers by up to 10%, but 'C 10015' solution and aldicarb granules increased them by 3 and 6% respectively.

Damage to seedling roots at Boston was decreased by 0·8% methiocarb seed dressing, and more by 1·12 kg γ-BHC/ha sprayed and worked into the seedbed; other seed treatments were not assessed at this site, and none at Welney. At both sites damage to roots was diminished by some of the liquids and granules, of which the most effective were 0·70 kg a.i./ha of heptachlor or methiocarb. (Dunning and Winder)

At Boston neither methiocarb at 0·70 kg/ha, nor γ-BHC put in the rows of seedlings repelled pygmy beetles, but may have repelled onychiurid and isotomid Collembola, soil mites, and first and second stage *Brachydesmus superus*. Gamma-BHC (1·12 kg/ha) sprayed on the soil did not affect pygmy beetle numbers but significantly decreased onychiurid Collembola, soil mite and *B. superus* numbers. (Baker and Dunning)

Seedling diseases and fungicide treatments. Early drilling after dry weather was unfavourable to *Aphanomyces cochlioides*, and although the fungus occurred in 10 out of 19 samples of seedlings with blackleg tested, the disease was not important in commercial crops.

Two trials on peat and one on sand in which *A. cochlioides* had been detected in the glasshouse, and a trial at Broom's Barn where it had not, tested 'Dexon' included in the seed pellet, or as granules or liquid applied to the furrow at drilling. *A. cochlioides* became prevalent only in one trial on peat where untreated plots had 20% of seedlings infected; 'Dexon' granules at 2·2 kg a.i./ha gave 4·5% infected seedlings; 'Dexon' liquid at 1·2, 2·2, 4·5 and 6·7 kg a.i./ha gave 2·0, 1·5, 0·7, 0·2% and 'Dexon' incorporated in pellets 3·2%. On average of four trials, all treatments decreased seedling emergence, final plant stand and sugar yield. Least harmful were pellets containing 'Dexon' and 'Dexon' liquid at 1·2 kg a.i./ha, which gave respectively 7 and 21% fewer seedlings, 6 and 5% fewer plants in the final stand and 3 and 8% less sugar than untreated seed. Seedling emergence and final plant stand were decreased less by 'Dexon' treatments at the site where moister soil favoured infection by *A. cochlioides*, but it was not possible to harvest this trial. (Byford)

Yellows and aphids

February was warmer than average (+0·9°C) in eastern England but March (−0·7°C) and April were colder than average. A comparison with weather in previous years predicted an average of 10% of plants throughout the country with yellows at the end of August. This proved wrong and the fieldmen's surveys at the end of August gave an average of only 2·3%, the smallest incidence ever recorded. Only 24 000 ha had more than 10% of plants with yellows and 510 ha more than 20%. Nevertheless, there were a few severe attacks, where virus spread from uncontrolled sources of infection (seed

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crops, clamped mangolds), to show that vigilance and control measures are needed to keep the root crop healthy.

In early June green aphids were about as numerous on sugar beet as in 1970, but they increased slowly. A few spray warnings were issued in the south-east, the fen area and in Shropshire. Black aphids were few on most crops and were more numerous in the West and the fen areas than elsewhere. About one-quarter of the sugar-beet acreage (43 000 ha) was treated with aphicides.

Aphid predators. Many ladybird beetles (coccinellids) survived the mild winter and they were even more abundant than in 1970. An average of 106 ladybirds was caught on each of seven sticky traps in sugar-beet crops in eastern England, compared with 61 in 1970 and 17 in 1969. Early in August some sugar-beet plants had more ladybirds than aphids on them. Many ladybirds were found on the coast of East Anglia during August and September (mainly *Coccinella 7-punctata, C.11-punctata* and *Harmonia 4-punctata*).

Hoverflies (syrphids), whose larvae attack aphids, were common in some beet fields in East Anglia, but fewer were trapped than in 1970. The adults of another group of dipterous flies, the dolichopodids, feed on aphids and may be important in controlling them. Many of the diptera caught in yellow water traps in Nigeria and the West Indies are dolichopodids and these are being compared at the British Museum with flies caught in a similar trap at Broom's Barn during 1971.

Some of the soil-inhabiting arthropods such as carabid beetles, which are active at night and so seldom seen, have been suspected of controlling aphids, but an experiment at Broom's Barn failed to demonstrate this. When the freshly cultivated soil between rows of sugar-beet plants in large plots was sprayed with γ-BHC to control soil-inhabiting predators but not aphids or their predators on beet leaves, the numbers of aphids did not differ in treated and untreated plots (e.g. on 22 July there was an average of 38 *A. fabae* and 0·2 *M. persicae*/plant in treated plots and 31 *A. fabae* and 0·1 *M. persicae*/plant on average in untreated plots). The incidence of virus yellows in September was also similar (8% infected plants in BHC-treated plots and 6% in untreated plots).

Plots of sugar-beet seed plants ('stecklings'), kale and turnip sown in July or August 1970 at Broom's Barn were severely damaged by the grazing of birds and mammals during the winter and did not support overwintering populations of *M. persicae* or of their predators.

Aphids infesting clamped mangolds and weeds. Forty per cent of the mangold clamps checked by fieldmen during late April were infested with aphids, a greater proportion than in any year since 1961, but only one-third of the infested clamps contained *M. persicae*. Some aphids from seven of 51 clamps were infective with BYV alone, from four with BMYV, and from two with both viruses.

Forty-eight of 91 samples of weeds collected during April alongside fields where sugar beet was grown in 1970 were infested with aphids. Three samples of groundsel contained plants infected with BMYV or a related virus.

Symptoms closely resembling those caused by BMYV are produced on leaves of *Claytonia perfoliata* by an aphid-transmitted yellowing virus found infecting lettuce in Norfolk and Suffolk; it seems identical to one described by Russell and Duffus (*Plant Pathology* (1970), **19**, 148–149) from Bedfordshire, which is related to beet western yellows and BMYV but does not infect sugar beet. Electron microscopy of sap from infected lettuce did not show any virus-like particles (with Woods, Plant Pathology Department).

***Aphis fabae* survey.** Numbers of eggs in December or January and peak spring populations of *A. fabae* on spindle bushes were assessed at 13 sites in East Anglia as part of a

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survey made with Imperial College, ADAS and others. Moderate numbers of eggs (0·2–1/bud) were found at two sites, few at most sites, but on average slightly more than in the previous year. Large peak populations were found at two sites (>50 aphids/bud) but most bushes averaged 0·5 aphids/bud or fewer. As expected, few crops in East Anglia were heavily infested. At Broom's Barn *A. fabae* did not damage beet, and infested field beans only in small plots or near hedges, after the pods had set.

Aphids on seed crops. Samples of leaves and shoots from 104 seed crops were examined during late May or June, and for the first time since 1963 *A. fabae* was not found. In late May many *M. persicae* were found on a crop in Gloucester where they over-wintered, and some were found during June in Essex, Gloucester and Wiltshire, but most crop samples had none.

Winged aphids on traps. Similar numbers of aphids were caught on sticky traps as in 1970, but the willow-carrot aphid and some cereal aphids were more numerous and *M. persicae* and *A. fabae* fewer than in 1970 (average of 10 : 32 *M. persicae*/trap, and only 30 : 905 *A. fabae*).

Influence of cultural practices. The percentage of plants and the number of infected plants/unit area of plots sprayed with insecticide decreased with increasing plant population. Plots with 19 800 plants/ha had 56% infected, with 36 300 plants/ha had 10%, and with 76 100 plants/ha had 2% infected at the end of October. Plots sown at different dates were sprayed with insecticide but only about 3% of plants had yellows so no effect of sowing date on yellows incidence was apparent. (Heathcote)

Leaf diseases

Downy mildew. Plants with downy mildew were scarce in both seed and root crops and none was recorded in sugar-beet and mangold stecklings. In cooperation with the National Institute of Agricultural Botany at their Regional Centre at Trawscoed, Cardiganshire, the susceptibility to downy mildew of varieties and breeders' lines were tested in a field where the disease was encouraged. The season was unusually dry and downy mildew spread slower than usual. Incidence on different varieties ranged from 8% to 31%; Anglo-Maribo Poly, Amono and Sharpe's Klein E had fewest infected plants and Bush Mono and Hilleshog Monotri had most. Varieties ranked in similar order of susceptibility to previous years, except for Hilleshog Monotri.

***Ramularia* leaf spot.** The effect on leaf spot of spraying with fentin hydroxide at 0·67 kg a.i./ha or benomyl at 0·28 kg a.i./ha on 3 and 17 May was studied on an open, direct-drilled seed crop at Stonesfield, Oxfordshire. A third spray could not be given on 1 June because the crop was too large. The per cent leaf area covered with spots was estimated on 100 mid-stem leaves/plot on 30 June, and the crop was harvested on 2 September. *Ramularia* spread rapidly during June on unsprayed but not on sprayed plants. Leaves from unsprayed plants had 5·2% of their leaf area covered with spots whereas those with one or two benomyl sprays and one or two fentin hydroxide sprays had 0·4%, 0·2%, 1·0% and 0·2% of leaf affected respectively. The one or two benomyl or fentin hydroxide sprays gave respectively 2%, 22%, 0% and 11% more seed than unsprayed plots. Plant density had a small effect on leaf spot incidence for crops with 665, 129 and 17 thousand plants/ha which had 7·0%, 5·0% and 2·3% respectively of mid-stem leaf area covered with spots on 9 July.

At Swaton and Sutton St. James, Lincolnshire, in two seed crops grown *in situ* from

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stecklings raised under cereal cover, and in an open direct-drilled seed crop at Great Staughton, Huntingdonshire, plants were sprayed with fentin hydroxide at 0·67 kg a.i./ha between 28 April and 28 May. At Great Staughton *Ramularia* incidence was negligible, and sprays did not increase seed yield. At Sutton St. James, Lincs., plots given 1, 2 or 3 sprays of fentin hydroxide at 0·67 kg a.i./ha during May had 4·4%, 3·0% and 2·7% respectively of mid-stem leaf area covered by spots on 28 July compared with 6·8% in unsprayed plots, but sprays did not increase seed yield. At Swaton, Lincs., on 28 July, plots given none, 1, 2, or 3 sprays had 6·4%, 5·9%, 3·2% and 2·8% leaf spot respectively, and when harvested on 31 August the sprayed plots yielded 17%, 26% and 17% respectively more seed than unsprayed plots.

Between 1968 and 1971, 11 trials in Lincolnshire, Huntingdonshire and Oxfordshire tested the effect of fentin hydroxide on seed crops with *Ramularia* leaf spot. One, two or three sprays gave similar increases in seed yield, an average of 4%.

Late summer fungicide sprays. To study the possible effects on leaf survival and senescence of controlling leaf pathogens during late summer and early autumn, benomyl at 0·28 or 0·56 kg a.i./ha or fentin hydroxide at 0·34 or 0·67 kg a.i./ha were sprayed at Broom's Barn at three weekly intervals from 22 July to 23 September. On 25 October and at harvest on 25 November powdery mildew, rust, *Ramularia* leaf spot and *Phoma* leaf spot were present but scarce. Sprays did not affect root yield, sugar content or sugar yield, but increased yield of tops by 21, 26, 12 and 23% respectively. This large increase cannot be accounted for by controlling known leaf pathogens, and merits further study.

Violet root rot

In a field where, in 1969, a carrot crop severely infected with *Helicobasidium purpureum* had been ploughed in, and potatoes were grown in 1970, 4% of sugar beet lifted on 18 August were infected. Infected roots increased to 8% on 24 September, 26% on 2 November and 30% on 3 December. Attempts were made to control the disease by spraying fungicide on the soil in a 25 cm wide band along the rows before drilling, and rotovating in to a depth of approximately 25 cm, or by spraying onto the soil beside the rows of beet in July. Materials tested were (kg a.i./ha): mebenil at 11·2 and 22·4, quintozene at 11·2 and 22·4 and furcarbanil ('BAS 3191') at 11·2. The disease incidence was patchy, but none of the treatments significantly decreased the number of infected roots or increased yield at harvest on 3 December. (Byford)

Docking disorder

Survey. The relatively dry May did not favour Docking disorder and only 1455 ha of sugar beet were reported affected in June. The factory areas with most were Bury St. Edmunds (310 ha), Newark (243), Ipswich (224), Nottingham (188), Wissington (178) and Brigg (162). However, rain in many areas in the middle of June seemed to stimulate nematode activity and a further 1164 ha were reported in July, mostly (809 ha) from the Allscott factory area; this is unusually late for symptoms to appear. About 809 ha were fumigated commercially shortly before drilling.

When 40 potential Docking disorder sites and four on heavier soils were surveyed in June, plants on only 14 showed Docking disorder and on eight the crop seemed to recover during the summer. The average yield of unwashed hand-harvested beet from unaffected crops on light soils was 52·7 t/ha, 32·4 t/ha where symptoms persisted and 40·2 t/ha where symptoms disappeared. Root shape was better on unaffected fields. *Trichodorus* occurred in 27 and *Longidorus* in 17 of the fields; *Trichodorus* were more

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numerous during May in soil samples from sites with affected plants (207/litre) than from those with none (125/litre), but the variation in numbers made prediction of the disorder impossible.

Samples of stunted beet from 13 of the survey sites were tested for nematode-borne viruses but none found. Plants were infected with TBRV at Oxborough, Norfolk, and TRV at Gateforth, Yorks. Few plants with 'yellow blotch' were seen.

Injection methods. Trials at Holt, Norfolk and Aldwark, Yorkshire, compared injecting fumigants behind tines 20 cm deep with spraying in the soil beneath horizontal blades 20 cm deep. 'Telone' was applied at 45, 135 and 404 litre/ha on 29 September and 12 October respectively. Soil was sampled to assess *Trichodorus* early in March. 'Telone' (45 litre/ha) controlled nematodes better when injected as a 50% emulsion than when unemulsified at Holt, but the reverse was true at Aldwark. Increasing the amount of fumigant improved control of *Trichodorus* which was equally good by the two methods of injection (see Table 1). The average numbers of *Trichodorus* in control plots were 1806/1 and 756/1 at Holt and Aldwark respectively.

Only the trial at Holt was harvested; sugar yield was increased by the largest rates of fumigant.

TABLE 1

Effect of method of application and different amounts of 'Telone' on Trichodorus *and sugar yield*

(Numbers/litre soil)

Treatment Intended amount of 'Telone' litre/ha	Holt, Norfolk Actual amount litre/ha	Holt, Norfolk *Trichodorus* No./litre	Holt, Norfolk Sugar yield t/ha	Aldwark, York Actual amount litre/ha	Aldwark, York *Trichodorus* No./litre
0	0	1806	5·69	0	756
Subsoil spray					
*45	38	931	6·10	40	225
135	154	463	6·55	142	0
404	385	88	7·18	398	0
Tine injection					
45	48	944	6·51	55	225
*45	46	706	5·60	45	356
135	143	375	7·08	153	81
404	344	138	7·42	350	6

* As a 50% emulsion

Large scale trials. The effect of fumigant injected behind tines spaced 50 cm or 25 cm apart on nematodes was assessed after 2–3 months in trials organised by the Sugar Beet Research and Education Committee at Westleton, Suffolk, Gt. Cressingham, Norfolk, and Stourport, Worcestershire. Table 2 shows the numbers of the most common nematodes in the root zone of plants in untreated plots (A) and in plots given 1 ml 'D-D' or 0·67 ml 'Telone'/30 cm spaced 50 cm apart (B), or given 1 ml 'D-D' or 0·67 ml 'Telone'/30 cm spaced 25 cm apart (C), or 2 ml 'D-D' or 1·33 ml 'Telone'/30 cm spaced 25 cm apart (D). As in 1970, *Tylenchorhynchus* was controlled better than *Pratylenchus* at all sites and there were too few *Trichodorus* to estimate control reliably.

Samples taken in April/May 1971 from the 1970 trial sites at Westleton, Suffolk and Larling, Norfolk, which were both cropped with barley in 1971, showed that nematodes had multiplied in plots fumigated in 1970, but were still few in plots given most fumigant (treatment D). (Cooke)

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TABLE 2

Nematode control by fumigation

(for details of treatments A, B, C, D, see text)

Nematode	Trial	Nematodes/litre soil A	Nematodes as % of A B	C	D
Tylenchorhynchus	Westleton	1606	27	14	2
	Gt. Cressingham	1019	19	12	0
	Stourport	463	16	12	1
Pratylenchus	Westleton	1075	64	69	20
	Gt. Cressingham	150	25	42	13
	Stourport	169	41	22	22
Trichodorus	Westleton	88	7	21	0
	Gt. Cressingham	0	—	—	—
	Stourport	50	38	13	13
Other Dorylaimida	Westleton	875	12	11	4
	Gt. Cressingham	469	65	59	9
	Stourport	194	29	19	16

Soil was sampled before drilling from each of the 13 trials organised by the SBREC testing the effect of fumigants on Docking disorder. Part of each samples was autoclaved for 2 hours at 1·0 kg/cm^2; beet seed was sown in both this and in unsterilised soil and grown either outdoors or in a heated glasshouse. Available nitrogen was consistently more in the unsterilised than sterilised soil, and it seemed that nitrogen in the fertiliser, applied to the fields before sampling, was broken down during autoclaving and expelled as ammonia. Plants apparently grew similarly in sterilised and unsterilised soil, but when harvested and washed after five weeks (grown inside) or ten weeks (grown outside), those in unsterilised soil had the more extensive root systems. At harvest those in sterilised soil were heavier than in unsterilised soil, especially in pots grown outdoors. A few seedlings were attacked by *Aphanomyces* in two soils but no other important fungi were found. Two samples had substantial numbers of *Trichodorus*, and three moderate numbers of *Longidorus*. (Byford and Cooke)

Nematicide trials. At Gayton, solutions of 'C 14421' and 'Dupont 1410' (0·14, 0·56 and 1·12 kg/ha) and granules of aldicarb (0·24, 0·49), 'Tirpate' (0·28, 0·42) and fenamiphos ('Nemacur P') (0·10, 0·35) were drilled in the furrow with the seed. None appreciably affected seedling numbers but slightly decreased the post-singling plant populations. Docking disorder symptoms were not apparent but 'Dupont 1410' (0·56 and 1·12) and aldicarb (0·49) increased seedling vigour. Granules of aldicarb (0·49) and 'Dupont 1410' (0·35, 0·70 and 1·19) were drilled in the furrow with the seed at two other sites, Worlington, Suffolk, where Docking disorder was expected but did not become apparent, and Broom's Barn. At Worlington seedling numbers were unaffected but seedling vigour, as measured by visual scoring of the foliage, was slightly increased by 'Dupont 1410' (0·35 and 0·70) but not by the other treatments. Post-singling plant populations were greater on the 'Dupont 1410' plots, especially with 0·35 and 0·70 kg/ha, and all treatments increased sugar yield by 5–10%. At Broom's Barn seedling and plant numbers and vigour were unaffected by these treatments, but all of them controlled beet leaf miner; yield was not determined. (Dunning and Winder)

Herbicide trial. A trial on sand at Oxborough tested for interaction between effects of herbicide and damage by ectoparasitic nematodes, but the crop showed no ill-effects from either. (Cooke and Heathcote)

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TABLE 3

Nematode numbers/litre soil, eight weeks after treatment with 'D-D'

Distance from injected row (cm)	Depth (cm)	Gleadthorpe *Longidorus* spp.	Gayton *Trichodorus* spp.
0	0– 8	67	50
	8–15	200	133
	15–23	25	142
13	0– 8	992	133
	8–15	650	358
	15–23	225	333
25	0– 8	1217	150
	8–15	1575	358
	15–23	1192	683
Unfumigated plots			
0	0–23	800	1000

Row treatment with nematicides. Trials at five sites prone to Docking disorder again tested row treatment with 'D-D' (at 1·6, 3·3 and 6·6 ml/metre row) and 'Telone' (at 1·1, 2·2 and 4·4 ml/metre) applied about two weeks before drilling or immediately before drilling, aldicarb (at 1·1 kg a.i./ha) in the furrow with the seed, and top dressings with nitrogen. Table 3 shows the numbers of nematodes at three depths and three distances from the row injected with 3·3 ml of 'D-D'/m at Gayton, King's Lynn and at Gleadthorpe, Nottingham. As in previous years, this amount of fumigant killed nematodes only over a short distance from the line of injection, emphasising the importance of accurately matching drilling with injection to get the maximum effect from fumigation.

With the larger amounts of 'D-D' and 'Telone' applied immediately before drilling, seedlings averaged 22% fewer than in untreated plots. All amounts of 'D-D' and 'Telone' applied immediately before drilling made seedlings fewer at Gleadthorpe, where 6·6 ml 'D-D'/m and 2·2 ml 'Telone'/m applied two weeks before drilling also gave significantly fewer (on average 18%).

There was little evidence of nematode damage and yields were good at all sites (average 44·6 t/ha roots on untreated plots). The killing of seedlings by some treatments did not decrease yield except at Gleadthorpe, where the plots injected with the largest amounts of fumigants immediately before drilling yielded less than untreated plots. At all other sites almost all fumigation treatments slightly increased root yield; fumigation did not affect sugar percentage (average 17·4% in untreated plots). On average, the best treatments were 3·3 ml 'D-D'/m immediately before drilling and 1·1 ml 'Telone' immediately before drilling, which increased average root yield to 48·4 t/ha and 48·9 t/ha respectively. Aldicarb increased root yield in all trials but not sugar percentage (to 48·2 t/ha and 17·3% sugar on average). Nitrogen top dressings (average 17·3 kg/ha N) on each of three occasions between 19 April and 18 June, in addition to a seed bed dressing of 151–251 kg/ha N, increased root yield to 47·0 t/ha on plots not given nematicide, but did not further increase root weight on plots treated with aldicarb at 1·1 kg a.i./ha; they decreased sugar percentage to 16·9 and 17·1 respectively.

Fumigation/irrigation. At Gleadthorpe, 50 mm of irrigation water (in addition to 67 mm of rain) between 22 April and 10 May made sugar beet look more vigorous early in the season, but decreased root yield by 2·7 kg/ha and sugar content by 0·7%. Nematicides (3·3 ml/m 'D-D', 2·2 ml/m 'Telone' applied two weeks or immediately before drilling, and aldicarb, 1·1 kg a.i./ha with and without nitrogen top dressing) all

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increased root yields; irrigation increased root yields from fumigated plots. (Cooke, Dunning and Winder)

Seed production

Diseases in seed crops. In June, 77 sugar-beet seed crops distributed in all seed growing areas averaged less than 0·1% of plants with yellows, and only one crop had more than 1% infected plants. Very few plants with downy mildew were seen. In October, 124 steckling beds averaged 0·04% of plants with yellows, and the 116 of these that were in the Eastern Counties averaged less than 0·01%. Ten mangold steckling beds averaged 0·02% of plants with yellows. (Byford)

Factors affecting seed yield

Plant population. Plants spaced at 5 cm in rows 25 cm apart yielded more seed than plants thinned to 15 cm apart in 50 cm rows, which yielded more than plants transplanted at 76 cm × 76 cm. Transplants gave a greater proportion, but smaller amount, of large seed than the closely spaced *in situ* plants.

Nitrogen fertiliser. Seed yield was larger with 62 kg/ha than 125 kg/ha N applied to the seed bed. A top dressing of 250 kg/ha N at the end of February, March, April or May did not affect yield; nor did giving the dressing in two equal parts separated by one, two or three months. N increased nitrate in the leaf petiole from 106 ppm to 949 ppm within one month, but with nitrate at 688 ppm the plants were evidently getting enough N from the soil to give maximum yield.

Harvest date and method. Seed yield was more with barn drying, swathing or tripodding than from plants killed with diquat. With all methods, yield declined at later harvests because seed was shed. No method was better than any other in retaining seed.

Dwarfing chemicals. Sugar-beet seed crops are too tall to be directly combine-harvested, so attempts were made to dwarf plants by spraying once with chlormequat chloride ('Cycocel') or N-dimethylaminosuccinamic acid ('B-Nine') at 1000, 5000 or 10 000 ppm before (3 November) or after (16 March) vernalisation. Chlormequat chloride at 1000, 5000 or 10 000 ppm on 16 March had most effect but only shortened plants by 18%. Seed yield was not significantly affected by the sprays, although it was slightly less with the larger amounts of 'B-Nine'.

Anti-abscission sprays. Maximum germination of ripening seed is not achieved until some seed has shed. This is the large, best seed and attempts to prevent it shedding were made by spraying 1-naphthylacetic acid (NAA) or 2,4,5-T before (13 July) or after (11 August) pollination. Plants were not harvested until 8 September, to try to ensure shattering, but none of the treatments increased yield and the greater concentration of 2,4,5-T slightly decreased it.

Factors affecting seed performance

Sowing date, fertilisers and harvest date, and method. Different amounts of N and P fertilisers applied to the seed crop did not affect emergence in the field or seedling dry weight. Emergence and shoot dry weight were greatest with seed from early sown, late harvested seed crops. The percentage of seedlings that emerged in the field was greater from crops given nitrogen in May than in March.

Seed from tripodded plants gave poorer emergence than that from barn drying, desicca-

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tion or swathing. Late harvesting also increased seedling emergence and there was an interaction between harvest date and method; seedling emergence increased with delayed harvesting when the crop was desiccated or swathed, but not when barn dried or tripodded. Seedling shoot dry weight increased with later harvesting and was greater after tripodding than after other harvest methods.

Seed grading. Seed lots of different percentage germination from monogerm plants were graded for thickness, diameter and density. Only fractions with the desired germination and monogermity of more than 95% were retained in calculations to determine seed recovery. At best (initial germination 73%) only 674 g/kg were recovered, which represented 663 000 viable seeds recovered/kg seed. A further 169 000 viable seeds were lost in discarded fractions, of which the >6½/64 in. thick grade, which is mainly multigerm seed, accounted for 74 000. The remaining 95 000 viable seeds lost in the light (<2 in. differential water gauge in the aspiration column) and small (<3·75 mm dia) grades might be recoverable with more efficient machines.

When seed harvested from all plants in a crop of mixed male sterile monogerm and pollinator multigerm plants was graded, recovery of monogerm seed was about half that above.

TABLE 4

Recovery of seed from monogerm sugar-beet seed plants (g/kg) at different germination percentages

Desired germination after processing	Germination as threshed (%)				
	33	50	64	70	73
60	9	252	416	645	674
70	0	86	250	547	674
80	0	10	138	135	517
90	0	0	18	40	20

Storage. When sown in compost, the percentage of seed stored at 5, 10 and 15% moisture content for 22 months that produced seedlings was 68, 63 and 47 (±1·2) respectively. The seed stored at 5% moisture content gave seedlings with largest shoot fresh weights. The percentages of other seed, held at 5, 10 or 15% moisture content or open stored for 10 months, that gave seedlings were 81, 78, 72 and 60 (±2·1) respectively. Storage at 15°C gave on average 6% fewer seedlings than storage at 10°C.

Soil type and seed variety. Seed of var. Amono, Bushmono, Monotri and Monobeet, was sown into peat fen, limestone loam, flinty loam and sandy loam. The different varieties gave similar numbers of seedlings and seedling shoot dry weight, but fewer seedlings grew on the flinty loam soil than on the others. The peat fen soil produced significantly heavier seedling shoots than the other soils, possibly because it was slightly warmer.

Soil condition and seed size. Eight soil conditioners applied to sandy clay soil at Saxmundham had no effect on seedling emergence or shoot dry weight. Seed size did not affect emergence but larger diameter seeds gave significantly heavier seedling shoot dry weights. (Longden)

Sugar-beet manuring

The experiments dealing with magnesium, nitrogen, phosphorus and potassium were done in cooperation with the British Sugar Corporation in 1970.

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Magnesium. Six experiments compared kieserite and calcined magnesite and measured response to magnesium in some areas where few experiments have been made with magnesium fertiliser. Fields were chosen so that all soils were in the range 0–50 ppm exchangeable magnesium. The treatments tested were 0, 188 and 378 kg/ha calcined magnesite (0, 102, and 202 kg/ha Mg); 314 and 628 kg/ha kieserite (51 and 102 kg/ha Mg). All plots received a basal dressing of 125 kg/ha N, 27 kg/ha P, 104 kg/ha K and 377 kg/ha agricultural salt. Mg increased yield considerably at Ipswich, Kidderminster and Newark but not at Brigg, Bury St. Edmunds and Spalding. Kieserite was more effective than calcined magnesite; and 102 kg/ha Mg as kieserite increased yield more than 202 kg/ha Mg as calcined magnesite; its effect on symptoms of deficiency was more obvious and it increased the concentration of magnesium in the crop more than magnesite.

Two sites where experiments started in 1966, in the King's Lynn and Wissington factory areas (*Rothamsted Report for 1966*, 292), were cropped with sugar beet. Kieserite given in 1967 was nearly as effective as that given in the sugar-beet seedbed in 1970. Magnesium limestone given in 1966 increased yield and exchangeable soil magnesium in 1970. Ground chalk, also given in 1966, decreased magnesium uptake by the crop in 1970 and increased the severity of deficiency symptoms at the King's Lynn site. Such long-term experiments provide much useful information about magnesium fertiliser unobtainable from annual ones.

Nitrogen and soil type. Further experiments were made to determine whether soil type affects nitrogen requirement of sugar beet and to study the relationship between the amount of nitrogen fertiliser given and yield of sugar. Fields adequately manured with phosphorus, potassium and sodium were given eight equal increments of nitrogen ranging from 0 to 290 kg/ha N as 'Nitro-chalk'. Three were on soils with a sandy texture, four on shallow, calcareous soils and two on deep, heavy clays.

Responses to nitrogen were larger than usual on all soil types. The crops on sandy soils needed 125 kg/ha N for maximum yield; giving more did not affect sugar yield but greatly decreased juice purity. The crops on calcareous soils and the two on clays needed, on average, a little more nitrogen for maximum sugar yield. The larger than usual responses on the calcareous loams and the clays probably resulted from compacted seedbeds and slow early growth.

Phosphorus. Five experiments were made to measure response to 0, 14, 28, 56 and 112 kg/ha P on fields adequately fertilised with nitrogen, potassium and sodium. The fields were chosen by soil analysis so that the sodium bicarbonate–extractable soil–P values were in the range 0–9 or 10–15 ppm (ADAS indices 0 and 1). Most fields where sugar beet is grown contain much more extractable P, especially on farms with a good standard of husbandry. These are where experiments are mostly made, so we have little knowledge of response to phosphorus fertiliser on soils poor in extractable P. Three of the five experiments showed a profitable return from the fertiliser and the largest dressing tested (112 kg P/ha) gave most sugar. However, on average, there was little return from using phosphorus even on such fields. The fertiliser had no effect on either sugar percentage or juice purity.

Potassium. Four experiments were made to measure response to 0, 42, 84, 168 and 336 kg/ha K, with and without 377 kg/ha agricultural salt, on fields adequately fertilised with nitrogen and phosphorus. The fields were chosen by soil analysis to have ammonium nitrate–exchangeable soil K values in the range 0–60 or 61–120 (ADAS indices 0 and 1). Crops on all four fields were very responsive to potassium and sodium fertilisers. Without

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sodium, the largest dressing of potassium tested, 336 kg/ha K, was needed for maximum sugar yield. Sodium greatly decreased the response to potassium but, even so, about 84 kg/ha K was also needed. (Draycott)

Plant nutrients

Potassium and sodium. The growth of sugar beet on Dunholme field given chemically equivalent amounts of sodium and potassium was studied. Treatments were 74 and 296 kg/ha Na as agricultural salt and 46 and 184 kg/ha K as muriate of potash. Bush Mono seed was sown to a stand at 7·5 cm spacing, and the crop was sampled at monthly intervals from May until November from an area of 2·5 m^2. Yield, leaf area index (LAI) and the concentration of sodium and potassium in the crop were measured at each sampling, and sugar yield at the last two harvests.

Fewer seedlings emerged on plots given sodium, probably because sowing was too soon after it was applied, although potassium applied at the same time did not affect seedling numbers. Thus the LAI and dry matter yield were initially lessened by sodium. By July, plants on plots with sodium had a larger LAI and total dry matter than on plots with either rate of potassium. The concentration and uptake of sodium and potassium increased with the amount applied but each depressed the concentration and uptake of the other. At harvest, all combinations of sodium and potassium increased the sugar percentage and the sugar yield. On average, sodium increased sugar yield by 1·09 t/ha and potassium by 0·21 t/ha. The small dressing of potassium and the large dressing of sodium given together gave the largest increased sugar yield of 1·39 t/ha. (Farley)

Manganese. The experiments described last year (*Rothamsted Report for 1970*, Part 1, 265) were repeated in the Ely, Peterborough and Wissington factory areas. At Ely the soil contained 0·9 ppm water-soluble (W/S), 0·1 ppm exchangeable (Ex), 47·1 ppm easily reducible (E/R), and 12·5 ppm available (Av) Mn, and the pH was 7·5. Sixty per cent of the plants not given manganese showed deficiency symptoms during June, 30% of those given 9 kg/ha Mn as a foliar spray and none of those sprayed with 18 kg/ha. Applying Mn to the soil had no effect.

The soil at Peterborough contained 0·2 ppm W/S, 0·3 ppm Ex, 3·4 ppm E/R and 2·7 ppm Av Mn and the pH was 7·3. Spraying plants with 9 kg/ha Mn decreased the percentage of plants showing deficiency symptoms from 50 to 22% and spraying with 18 kg/ha to 0%. As at Ely, Mn applied to soil did not affect the percentage of plants showing symptoms during June. At Wissington, none of the plants showed manganese-deficiency symptoms. The soil, pH 6·9, contained 0·6 ppm W/S, 0·7 ppm Ex, 108·6 ppm E/R and 9·1 Av Mn.

At harvest, manganese whether applied to foliage or soil increased the sugar yield, on average of all experiments by 0·4 t/ha.

A sugar-beet crop on West Row Fen, in which 90% of the plants showed deficiency, was sprayed with 9, 18 and 27 kg/ha Mn as $MnSO_4$, applied in one, two and three sprayings with 9 kg/ha Mn. All amounts alleviated the symptoms, and 9 kg/ha Mn increased the sugar yield by 0·43 t/ha, 18 kg/ha Mn by 0·56 t/ha and 27 kg/ha Mn by 0·91 t/ha sugar. (Farley)

Distribution of nutrients. Little is known about the distribution of nutrients in different parts of sugar beet, especially in leaves of different sizes. Six plants taken at four-weekly intervals between 14 June and 4 October from a crop adequately supplied with nutrients, were divided into root, crown and top. The crown was further divided into bud and shoulder, and the tops into laminae and perioles according to leaf size. Each plant part

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was then analysed for the six major elements (N, P, K, Na, Ca, Mg). Concentrations of nutrients in laminae were related to their concentration in the petioles, and all elements except potassium were more concentrated in laminae than in petioles. The concentration of phosphorus and nitrogen, but not of potassium, decreased with increase in size of leaf, and especially on senescence. The concentration of nitrogen in leaves of the same size decreased progressively through the season, except for those smaller than 32 cm^2. Potassium, phosphorus and calcium also became less, and sodium fluctuated; magnesium also decreased between 14 June and 12 July but then remained constant. (Wright)

Time of application of PKNaMg. Three long-term experiments were started, two in East Suffolk and one in Essex. The objects were to compare PKNaMg fertiliser applied before ploughing with applying it to the seedbed, and to measure response by each crop in the rotation to K, Na and Mg separately and together. All three fields were cropped with sugar beet and the amounts of fertiliser used were 0 and 167 kg/ha K; 0 and 377 kg/ha agricultural salt; 0 and 102 kg/ha Mg and 27 kg/ha P.

In each experiment, sugar yield was the same whether the fertiliser was given before ploughing or to the seedbed. On average, potassium increased yield by 0·30 t/ha sugar, sodium by 0·11 t/ha and magnesium did not increase it. These preliminary results suggest that on fertile fields such as these, yield is not lost when PKNaMg fertiliser is ploughed down. (Bennett)

Time of applying fertilisers. An experiment on New Piece compared 75, 150 and 225 kg/ha N applied before ploughing during December, with the same amounts applied in spring, and with 150 kg/ha applied before ploughing plus 36 kg/ha during spring. During May the plants where nitrogen was applied before ploughing were smaller than those where nitrogen was applied during spring, and analyses of soil to a depth of 60 cm showed that this was because the fertiliser had leached. However, by July the plants where nitrogen was applied before ploughing began to take up the nitrogen from below 60 cm, and during August looked much more vigorous than those on plots given nitrogen during spring. The plots given nitrogen in December and spring yielded the same amounts of sugar. (Chapman)

Another experiment on New Piece compared phosphorus fertiliser applied during autumn or to the seedbed, and nitrogen applied before and after sowing. Phosphorus was applied on 16 October and 23 March at 0, 14, 28, 55 and 110 kg/ha P and nitrogen on 23 March and 1 April at 125 kg/ha N; the crop was sown on 25 March. Phosphorus increased yield on average by 0·25 t/ha sugar, but the time phosphorus or nitrogen was applied did not affect yield. (Draycott)

Nitrogen, cations and varieties. The experiment started last year (*Rothamsted Report for 1970*, Part 1, 264) in cooperation with Dr. G. E. Russell of the Plant Breeding Institute was repeated on Dunholme field. The number of seedlings emerging from each variety differed greatly, 9/metre of row from Anglo Maribo Poly Seed, 14 from Sharpe's Klein E and VT 137, and 16 from Maris Vanguard. Fertilisers had little effect on emergence but nitrogen, sodium and potassium greatly increased sugar yield, nitrogen by 1·36 t/ha, sodium by 0·74 t/ha and potassium by 0·55 t/ha. All four varieties needed 75 kg/ha N, and sodium or potassium, for maximum sugar yield. (Draycott)

Irrigation

Fertiliser, spacing and irrigation. This experiment examined how density of plant stand, fertiliser and irrigation affect yield and water use by sugar beet. The plant populations

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(S_1—18·5, S_2—37·0, S_3—74·0 and S_4—130 thousands/ha), potassium (O, 140 kg/ha K), sodium (0, 245 kg/ha Na) and irrigation treatments were as before (*Rothamsted Report for 1970*, Part 1, 266).

Without irrigation, the soil moisture deficit (SMD) measured with a neutron moderation meter, was 100 mm on S_4 and 75 mm on S_1 during July and 150 mm on both populations during September. Water was used from each soil horizon to 160 cm and 120 cm on S_4 and S_1 respectively. In contrast to previous years, S_1 extracted more water than S_4 from the surface horizons.

To prevent the SMD exceeding 40 mm a total of 130 mm of water was given. Even though there was a large difference between the soil moisture on irrigated and unirrigated plots for much of the season, response to irrigation was only 0·16 t/ha sugar. The soil returned to field capacity at the end of June in 1971 so there was no shortage of water at this critical time for the sugar-beet crop. In contrast, the response to irrigation in 1970 was 1·38 t/ha sugar when the soil moisture deficit was 54 mm at the end of June. The combination of good seedbed conditions, adequate water early and the warm sunny July and August gave large yields. The mean sugar yields from the four populations were S_1—6·77, S_2—8·48, S_3—8·81 and S_4—8·86 t/ha.

The crops on plots S_1 and S_4 were sampled at two-week intervals during June and then at four-week intervals until harvest, to measure yield and nutrient uptake. The dry matter of the tops was increased by fertiliser more on S_4 than on S_1 until mid-summer, whereas response by dry matter of roots was similar until the autumn when it became larger on S_1. Irrigation gave similar large increase in top dry matter with both plant populations but increased root dry matter only on S_4. Irrigation increased yield more without than with fertiliser. Differential effects of the treatments on dry matter of tops during the summer largely disappeared during the autumn. (Durrant and Messem)

Time and amount of irrigation. This experiment measured the response of sugar beet to irrigation at different times and compared one with several waterings. Water was applied to individual plots each month from June to September with perforated 'lay-flat' flexible tubing. The single watering was given when the deficit reached 25 mm. On plots watered monthly (125 mm total), the sugar yield response was 1·42 t/ha. The single waterings in June (25 mm), July (50 mm) and August (50 mm) each increased yield by about 0·41 t/ha, whereas the one during September (50 mm) made the sugar percentage less without increasing the sugar yield. The site was a shallow stony soil which may account for the larger yield response to irrigation than in the fertiliser, spacing and irrigation experiment above. (Messem)

Plant spacing

Plant density and distribution. Whether the regularity of distribution of plants affects yield was examined at four plant population densities (25 000, 49 000, 74 000 and 98 000 plants/ha). Seed of var. Amono was sown on 2 April or 4 May on Dunholme field in rows 51 cm apart, and the crop was singled by hand. Plant spacings along the row were arranged to be either equal, or half the spacings were twice as large as the remainder, or half were four times as large as the remainder. Harvest was in early November. The April-sown crop yielded more roots with a greater sugar percentage, but less tops than the May-sown. At the sparsest plant density, root, sugar and top yields at either time of sowing were much less than with the other plant populations, all of which yielded similarly (Table 5). Root and sugar yield, especially at 25 000 plants/ha, were smaller with irregular than regular spacing, but not top yield or sugar content. The early-

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TABLE 5

Sugar yield (t/ha) from different sowing dates, plant densities and distributions

	Sowing date									
	2 April					4 May				
Density (1000s/ha)	25	49	74	98	Mean	25	49	74	98	Mean
Distribution										
Regular	7·25	8·47	8·59	8·42	8·18	6·29	7·17	7·26	7·54	7·07
Irregular	6·14	8·34	8·57	8·63	7·92	4·93	7·21	7·67	7·52	6·83
Very irregular	6·09	8·05	8·04	8·83	7·75	4·83	6·79	7·33	7·16	6·53
Mean	6·49	8·29	8·40	8·63	7·95	5·35	7·06	7·42	7·41	6·81

sown plants were not obviously better able than the late-sown to compensate for sparse stands or irregular spacings. (Jaggard)

Time of sowing and seed spacing. This experiment on New Piece field was the first in a series to measure the plant densities and yields obtained by drilling to a stand at different seed spacings or different dates. Pelleted monogerm seed var. Bush Mono was sown on three dates (25/3; 14/4; 4/5) at 12·5 cm or 20 cm spacing, giving harvested plant densities of 97 500 and 65 800/ha respectively, or drilled at 6·5 cm spacing and hand singled in an attempt to give uniform stands of plants at densities resembling those from the two wider seed spacings. Plots sown in March and hand singled to the thinner density yielded 10·35 t/ha of sugar in December (Table 6). The plots drilled at 12·5 cm gave the greatest yield from the second and third sowings. Yields were smaller at the extremes of plant density irrespective of sowing date or method of establishing the stand (Table 6). Plant densities increased with later sowing. The stand from 20 cm spacing was inadequate at all sowing dates, and that from 12·5 cm spacing was too dense from all sowings, but especially the last one.

TABLE 6

Sugar yields and plant densities of sugar beet for different sowing dates and seed spacings

	Sown at 12·5 cm spacing		Hand singled		Sown at 20 cm spacing		Hand singled		Mean	
	t/ha	Plants/ha (000s)	t/ha	Plants/ha (000s)	t/ha	Plants/ha (000s)	t/ha	Plants/ha (000s)	t/ha	Plants/ha (000s)
S_1	10·29	93	10·14	105	9·92	59	10·35	74	10·18	83
S_2	10·22	94	9·80	105	9·71	67	10·02	79	9·94	86
S_3	9·37	105	9·23	111	9·06	71	9·17	81	9·21	92
Mean	9·96	97	9·73	107	9·56	66	9·85	78	9·77	87

Nitrogen fertiliser was either broadcast in the seedbed or applied with a Horstine Farmery granule applicator at sowing as a band either side of the rows. Method of application had no significant effect on either seedling emergence or sugar yield. (Webb)

Twin rows on ridges. The yield from pelleted Bush Mono seed sown on 2 April at 12·5 or 20 cm spacing in twin rows 25 cm apart on flattened ridges with centres 76 cm apart was compared with a similar row arrangement on the flat and with conventional rows 50 cm apart (*Rothamsted Report for 1969*, Part 1, 331). Spacing seed at 12·5 cm gave 107 000 plants/ha and at 20 cm about 75 000 plants/ha. Corresponding plant densities on 50 cm rows were 85 and 60 thousands/ha. Sugar yields from the twin rows were

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9·7 t/ha whether on ridges or on the flat and this row arrangement on average yielded 0·45 t/ha more than the 25 cm rows. On average the two seed spacings gave similar yields. (Hull)

Soil compaction

An experiment on New Piece tested the effects of soil compaction on fertiliser requirement and yield of sugar beet (*Rothamsted Report for 1969*, Part 1, 130; *for 1970*, Part 1, 265). The soil conditions tested were: (1) compaction produced by cultivating the soil during February and allowing it to weather before drilling early in April; (2) a seedbed produced by shallow cultivations immediately before drilling; (3) a very open seedbed produced by a powered harrow operating 15·5 cm deep immediately before drilling. At seedling emergence the mean soil bulk densities for the surface 16 cm of each treatment were: compacted seedbed, 1·65 g/ml; normal seedbed, 1·47 g/ml; open seedbed, 1·30 g/ml. Slightly more seedlings emerged on the normal than on the other seedbeds and with the smaller amounts of either nitrogen or phosphate fertilisers than with the larger. Sugar yield was less by 0·9 t/ha on the compacted seedbed and 0·4 t/ha on the normal seedbed than on the open one.

Sugar content was the same on all. The crop responded to 150 kg/ha of nitrogen on the compacted plots, but only 75 kg/ha on the normal and open seedbeds. More than 75 kg/ha N decreased sugar percentage. There was no significant effect from extra phosphate fertiliser.

Compacting sandy soils prone to produce Docking disorder sometimes improved the growth of sugar beet (*Rothamsted Report for 1970*, Part 2, 226). An experiment at Worlington, Suffolk, on such a soil containing *Longidorus* tested compacted and uncompacted seedbeds in factorial combination with 0 or 0·84 kg/ha of aldicarb ('Temik 10GV') granules in the seed furrow. When the seedlings emerged, the mean soil bulk density to a depth of 16 cm was 1·37 g/ml on the uncompacted plots and 1·58 g/ml on the compacted. Slightly more seedlings established on the uncompacted plots, attributable to more seeds damaged by field mice on compacted ones. At harvest the yield of roots and sugar was approximately 2 t/ha and 0·4 t/ha less respectively on the compacted than the uncompacted plots; aldicarb increased yield by 3·3 t/ha of roots and 0·6 t/ha of sugar. (Jaggard)

Root studies

Root growth of sugar beet, potatoes and barley was again studied in the observation pits and compared with extraction patterns of soil moisture, measured with a neutron moderation meter. Half of each plot was compacted by tractor wheelings during March. Bulk density measurements showed that the soil had been compacted to a depth of 30 cm. Compacting the soil slowed the germination of barley and growth of all crops, especially barley. Leaf cover, and moisture use, were always less on compacted plots (Table 7).

TABLE 7

Effect of soil compaction on leaf cover and soil moisture deficit

	Sugar beet	Potatoes	Barley
Maximum leaf cover (%)			
Open seedbed	95	85	100
Compacted seedbed	90	45	50
Maximum soil moisture deficit (mm)			
Open seedbed	145	95	90
Compacted seedbed	135	80	50

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By mid-June roots in uncompacted soil had penetrated to about 100 cm (barley), 65 cm (potatoes) and 45 cm (sugar beet). Barley and sugar-beet roots eventually penetrated below 120 cm but potato roots not below 110 cm. (Durrant)

At intervals from April to September the soil atmosphere was sampled from probes placed near the soil surface and also at depth in compacted and non-compacted soil. The samples were analysed for oxygen, carbon dioxide and ethylene by gas chromatography at the ARC Letcombe Laboratory. Soil compaction increased the amount of ethylene near the soil surface under potatoes and barley, but not under sugar beet early in the season. Ethylene concentration decreased with time and after 10 May it was not detectable. Compaction also increased the carbon dioxide concentration but had a variable effect on oxygen. On average, carbon dioxide decreased and oxygen concentration increased with time. On every occasion the concentration of oxygen was as in air whereas carbon dioxide was three times as much.

In September the soil atmosphere under sugar beet was sampled before and after applying 150 mm of water. Irrigation decreased the carbon dioxide concentration in the surface of the uncompacted plot but increased it at depth. Irrigation increased carbon dioxide concentration at all depths on the compacted plot; oxygen concentration did not change and ethylene was not detected. (Farley)

Time of sowing, harvesting and nitrogen need

An experiment testing times of sowing and harvesting produced the yields shown in Table 8. Root yields from 0, 75, 150 and 225 kg N/ha averaged 40·5, 48·5, 50·5 and 50·2 t/ha of roots at 17·6, 17·7, 17·5 and 17·2% sugar giving 7·06, 8·58, 8·86 and 8·59 t/ha of sugar respectively. Early sowings responded to 150 kg/ha of nitrogen but the late sowings did not respond to more than 75 kg N/ha. Delaying harvest until November increased yield considerably, but further delay did not.

TABLE 8

Sugar yield and percentage sugar of sugar beet for different sowing and harvesting dates

	Lifting date							
	28 Sept.		2 Nov.		8 Dec.		Mean	
Sowing date	t/ha	%	t/ha	%	t/ha	%	t/ha	%
23 March	7·62	17·9	9·46	17·7	9·36	16·5	8·81	17·4
14 April	7·13	18·4	8·92	17·9	9·20	16·9	8·42	17·7
4 May	6·43	18·1	8·04	17·6	8·31	16·7	7·59	17·5
Mean	7·05	18·1	8·81	17·7	8·96	16·7	8·26	17·5

Plants from the three times of sowing given 0, 150 and 225 kg/ha of nitrogen were sampled and analysed for growth seven times between 14 May and 28 September. The leaf area index (LAI) of all sowings increased quickly and at the end of June the first-sown crop had a mean LAI of 1·7, and the second sowing one of 1·1. By mid-July all three sowings had approximately the same leaf area, but the later-sown crops had accumulated less dry matter, and had much less dry matter in their roots. The leaf area of plants with 150 and 225 kg N/ha exceeded the area of those without N. This difference developed by early June on the early sowing, more than a month earlier than in 1970. (Jaggard)

Nitrate in petioles was again measured in plants from the late harvested plots. It was 1000 ppm or more on all plots until late June and decreased between late June and mid-

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July. Plants from plots without nitrogen fertiliser contained less than 50 ppm NO_3-N by mid-July and less than 100 ppm until late September. With 150 kg/ha and 225 kg/ha N petiole NO_3-N exceeded 100 ppm until the second half of August. (Wright)

Analysis of sugar-beet crowns

The sugar beet contract demands that roots must be topped squarely immediately below the lowest leaf bud, because crown tissue contains impurities that prevent sucrose crystallising. The relative weight, sugar and impurity contents of the tissues discarded, and their potential influence on sugar yield and extraction, were measured.

Samples of roots of very different sizes were taken from an experiment on irrigation and plant spacing and trimmed to remove leaf stalks. Cossette samples were taken with a specially designed grating machine from the growing points, crowns and storage roots. Each part was weighed and analysed for Na, K, α-amino nitrogen, invert sugar and sucrose concentration. The juice purity and extractable sugar per root were calculated for whole, scalped and topped beet. On average, untopped beets weighed 17% and scalped beet 13% more than topped beet. The untopped largest beets weighed 24% more than topped ones and the smallest 13% more. Corresponding scalped beets weighed 21% and 9% more. The sucrose concentration in the scalp was 14·2%, compared with 16·7 in the crown and 19·3% in normally topped beet, and the calculated juice purities were 86% in the scalp, 90% in the crown, and 93% in topped beet. However, the crown is relatively small, so its impurity content has a small effect on the impurity concentration of the whole beet. The juice purity for whole, scalped and topped beets was calculated to be 92·4%, 92·6% and 93·0%, and the relative content of extractable white sugar 117, 113 and 100 respectively. (Hull and Last)

Growth control chemicals

An experiment on Dunholme field tested the effect of the growth regulating chemical 'Mon-0845' (supplied by the Monsanto Chemical Corporation) on the yield of sugar beet var. Monotri. The chemical was sprayed on the leaves at the rates of 1·1 kg/ha either in mid-August (M_2) or as a split application in mid-July and mid-August (M_3) and compared with untreated (M_1). These treatments were in factorial combination with two amounts of nitrogen fertiliser, 150 or 225 kg/ha; harvest was either early in October or November.

The chemical soon restricted the growth of tops, and during a period of water stress in September the sprayed plants wilted more than unsprayed. It decreased root, sugar and top yield, but increased the sugar percentage of the roots, most when applied as a single dose. Delaying harvest by a month increased root and sugar yield, but M_2 plants increased much less than M_1 or M_3. Giving additional 75 kg/ha of nitrogen fertiliser, decreased the sugar yield from all treatments, most on the unsprayed plots where it averaged 0·8 t/ha. The chemical temporarily slowed plant growth, but this effect had disappeared on plants sprayed in July by the middle of October, and they grew more between the first and second harvest than those plants sprayed once in August. (Jaggard)

Herbicides and weed control

Mr. W. E. Bray of Norfolk Agricultural Station, tested various pre-emergence and post-emergence herbicides at Broom's Barn. On plots where they controlled weeds, yields of up to 9·16 t/ha of sugar were recorded whereas unweeded plots yielded only 7·90 t/ha.

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Stubble cultivations. An experiment of the same design as described last year (p. 268) was started in 1968 on New Piece. Applying 'Banlene Plus' to control broad-leaved weeds did not significantly affect the yields of Cappelle wheat in 1969 or Sultan barley in 1970, but significantly decreased the proportion of the ground covered by weeds before ploughing in December 1969 from 7·0% to 0·5% (±1·57), and from 2·1% to 0·1% (±0·76) in December 1970.

In 1971 the experiment was drilled with sugar beet var. Bush Mono at 12·7 cm spacing. Herbicide treatments and observations were as described last year. Stubble cultivations in the two previous years did not consistently affect weed numbers in the beet crop, but the use of a herbicide in the preceding cereal crops made them significantly fewer in the beet, especially such perennial weed species as *Rumex crispus* and *Cirsium arvense* (L) both before and after applying pyrazon ('Pyramin') or phenmedipham ('Betanal E'). 'Pyramin' controlled weeds significantly better than 'Betanal E'. No treatment affected sugar yield, root yield or plant population. (Jaggard)

Varieties

Six monogerm and four multigerm commercial varieties were sown at 12·7 cm spacing on 16 April on Dunholme field. Emergence ranged from 50% to 70% with an average of 4% doubles for the monogerm varieties and 19% doubles for the multigerm varieties. Harvested plant populations averaged 84 thousands/ha. The six monogerm varieties gave a sugar yield of from 94% to 103% of the average of the four multigerm varieties, which yielded 8·59 to 9·13 t/ha of sugar. (Webb)

Cereal and rotation experiments

Fertilisers on rotation crops. This was the seventh year of the experiment testing fertilisers applied during a crop rotation of sugar beet, winter wheat and barley. (For the fertiliser dressings, see *Rothamsted Report for 1965*, 279, Table 7.) Yields and nutrient balance for the first six years are given in Part 2 of this Report.

Table 9 shows the effect of the treatments in 1971. Wheat and barley needed N_2 (150 and 100 kg/ha nitrogen respectively) but N_1 (100 kg/ha nitrogen) was enough for sugar beet. As before, sugar beet responded greatly to potassium and sodium fertilisers.

TABLE 9

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

	Wheat grain (t/ha at 85% DM)	Barley grain (t/ha at 85% DM)	Sugar beet (sugar t/ha)
Mean yield	3·92	3·69	6·01
Response to:			
N_1	+1·77	+1·48	+0·58
N_2–N_1	+0·19	+0·34	−0·30
P_1	+0·06	−0·04	−0·16
P_2–P_1	+0·05	+0·33	+0·85
K_1	0	+0·01	+0·80
K_2–K_1	−0·34	−0·16	+1·57
Na	+0·05	+0·16	+1·51
FYM	+0·09	+0·13	+0·87
Compound 1	+1·83	+1·41	+1·92
Compound 2–Compound 1	−0·58	+0·40	+0·11

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The large response to a moderate dressing of NPK (Compound 1) by wheat and barley was mainly from the nitrogen, and to sodium and potassium by sugar beet. (Durrant)

Frequency of beet and barley. Yields for the first six years of this phased rotation experiment (*Rothamsted Report for 1966*, 298) are given in Part 2 of this Report. In 1971, sugar yields were similar in the continuous sugar beet and arable rotations (average 6·50 t/ha) but less after the two-year grass ley (5·80 t/ha). Sugar beet in none of the rotations needed more than 125 kg/ha N, which increased yield by 1·71 t/ha sugar. Yields of barley grain were 3·86, 3·66, 3·55 and 3·12 t/ha at 85% DM when it followed sugar beet, one, two or three barley crops respectively. As previously, the grass crop following sugar beet established slowly and yielded 5·31 t/ha DM whereas second-year grass gave 10·37 t/ha DM. Yields of potatoes, barley and grass were much larger than in 1970. There was no residual effect from N applied to sugar beet on following barley. (Hull)

Nitrogen and fumigation. The experiment on Brome Pin (*Rothamsted Report for 1970*, Part 1, 270), to investigate residual effects of soil fumigation and form of nitrogen fertiliser on yields and pathogens, was continued. Examination of soil samples taken on 12 January showed not only that nematodes were well controlled in recently fumigated plots, but also that plant parasitic nematodes were fewer in plots fumigated in March 1970 than in unfumigated plots. Winter wheat was grown and the crop was sampled on 17 June after ear emergence. Table 10 shows nitrogen uptakes and the nitrate-N concentrations in the crop.

Fumigation did not affect NO_3-N concentration in the plants during June, and concentrations were greatest in plants given their fertiliser N as nitrate. Wheat grown on plots fumigated in both years contained on average 13 kg/ha more NO_3-N than on plots fumigated only in 1970, although these contained 4 kg/ha N more than on unfumigated plots.

TABLE 10

Nitrogen uptake, NO_3-N concentration in winter wheat, grain and straw yields, in the nitrogen and fumigation experiment

N dressing, kg/ha	Fumigated in	N uptake, kg/ha	NO_3-N conc., ppm	Grain, t/ha	Straw, t/ha
0	—	25	0	1·71	2·03
	1969 and 1970	38	0	3·59	3·86
	1970 only	29	0	2·39	2·46
125 (NH_4^+)	—	62	25	3·43	3·55
	1969 and 1970	79	16	4·04	4·64
	1970 only	63	20	3·63	3·75
125 (NO_3^-)	—	61	100	2·48	2·95
	1969 and 1970	74	90	3·13	3·79
	1970 only	62	40	3·01	3·45

Yields of grain and straw were significantly increased by fumigation; fumigation in both years increased grain yield by 1·05 t/ha, and fumigation in one year by 0·47 t/ha (Table 10). Yields from nitrate nitrogen were significantly less than from ammonium. This suggests that fumigation increased yield partly by increasing the supply of mineral nitrogen to the crop and partly by inhibiting nitrification of ammonium nitrogen, lessening leaching of nitrogen during spring.

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Plots receiving 'D-D' every year were again fumigated on 14 September 1971. Soil samples taken on 18 October 1971 showed that most plant parasitic nematodes were as numerous in plots fumigated in March 1970 as in unfumigated plots, but fewer in plots fumigated every year. (Cooke and Last)

Magnesium and boron. This experiment (*Rothamsted Report for 1970*, Part 1, 271) was sown with winter wheat, variety Joss Cambier, on 5 November. The treatments applied in 1970 had no effect on appearance of the crop or yield. The average yield of grain was 3·30 t/ha and of straw 3·55 t/ha, both at 85% DM.

In February soil samples were analysed for exchangeable magnesium and boron, soluble in hot water. Soil not given magnesium contained 39 ppm Mg; given kieserite 50 ppm Mg; magnesium limestone 37 ppm Mg; calcined magnesite 45 ppm Mg; those not given boron, 1·02 ppm B and those given boron 1·10 ppm B. (Farley)

Irrigation and nitrogen for cereals. Experiments organised by the Botany and Chemistry Departments at Rothamsted compared the growth and yield of winter wheat and spring barley at Broom's Barn with similar crops at Harpenden (see pp. 106 and 60). At Broom's Barn the land for wheat on Flint Ridge field and for barley on Marl Pit was given 900 kg/ha Epsom salts and 1250 kg/ha of a 0 : 20 : 20 compound before it was ploughed. During the winter the Broom's Barn soil contained less mineral N than the Harpenden soil. The crops were top-dressed with 30–180 kg/ha N in six increments and water was applied in a factorial design to keep the soil moisture deficit in the range 13–39 mm. A total of 77 mm of water was applied to the wheat and 58 mm to the barley.

Yields of both crops were above average for Broom's Barn. Wheat yielded 5·8 t/ha grain without irrigation and 6·3 t/ha with irrigation; barley gave 5·3 t/ha without irrigation and 5·7 t/ha with irrigation. Both crops needed 157 kg/ha N for maximum yield both with and without irrigation. The slightly larger yields at Harpenden seemed to be associated with greater ability of the soil to supply N to the plants.

Rainfall during winter and spring kept the soil in both experiments at Broom's Barn near field capacity until the beginning of May. By then both crops had almost 100% leaf cover so that the wheat and barley removed similar amounts of water from the soil during May, June and July. May was very dry and the crops used soil reserves of water. In June heavy rain returned the soil to near field capacity. Both crops removed soil water to a maximum depth of 110 cm. (Draycott, Messem and Webb)

TABLE 11

Irrigation and nitrogen for wheat and barley at Broom's Barn

	Grain yield, t/ha at 85% DM N dressing (kg/ha)						
	30	60	90	120	150	180	Mean
			Wheat				
Without irrigation	4·61	5·56	5·64	6·06	6·35	6·36	5·76
With irrigation	5·13	5·74	6·40	6·80	6·88	6·36	6·22
Mean	4·87	5·65	6·02	6·43	6·61	6·36	5·99
			Barley				
Without irrigation	4·07	4·99	5·37	5·85	5·90	5·77	5·33
With irrigation	4·76	5·34	6·01	5·93	6·11	5·56	5·62
Mean	4·41	5·16	5·69	5·89	6·00	5·67	5·47

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TABLE 12

Effect of fungicides on the yield of barley

(t/ha at 85% dry matter)

Fungicide	Variety: Sultan	Midas	Julia	Berac	Mean (±0·094)
Untreated	3·15	3·68	3·37	3·70	3·48
ethirimol seed dressing	3·91	3·93	3·68	4·26	3·94
tridemorph	3·41	3·88	4·11	3·57	3·74
ethirimol spray	3·18	3·63	3·38	3·61	3·45
tetrachloroquinoxaline	3·15	3·62	3·53	3·89	3·55
	(±0·187)				
Mean (±0·084)	3·36	3·75	3·62	3·81	3·63

Fungicides on barley. Ethirimol ('Milstem') as a seed dressing was compared for control of mildew on four varieties of spring barley with sprays of tridemorph ('Calixin'), ethirimol ('Milstem') and tetrachloroquinoxaline ('Lucel') applied on 19 May. Mildew was more severe on Sultan and Berac than on Julia and Midas, and brown rust most severe on Sultan and Midas and least on Julia.

The ethirimol seed dressing controlled mildew well, better than tridemorph, the only sprayed fungicide that appreciably decreased mildew. All the fungicides except ethirimol spray increased the 1000 grain weight. (Webb)

Broom's Barn farm

Ploughing was completed by 14 January. Spring work started during the last week of February, but the land ploughed last proved difficult to work. Brome Pin field was deep cultivated, limed and spread with farmyard manure before ploughing in August. Part of Bullrush was also given farmyard manure. In addition to irrigation experiments, the ley and the non-experimental areas of beet were watered during the summer. All land was ploughed by the end of the year.

Cereals. The cereals were manured and sprayed with herbicides as in previous years. The wheat on Bullrush lodged and less grain was harvested than expected. Half of White Patch was sown with Maris Ranger in December and the remainder in mid-February when the soil was in fit condition following the last of the sugar beet to be harvested. Mildew was prevalent on all the wheat. All the barley was sown in early March. The 'Milstem' seed dressing kept the Sultan free from mildew but it was heavily infected with brown rust. Mildew was severe on Julia. Harvesting lasted from 9 to 31 August and grain moistures ranged from 14½ to 21%. The yields are in Table 13.

TABLE 13

Cereal and bean yields at 15% moisture

Field	No. ha	Variety	Yield (t/ha)
Marl Pit	4·85	Julia Barley	4·39
Little Lane	8·74	Sultan Barley (undersown)	4·40
Windbreak	2·32	Joss Cambier Wheat	5·08
Flint Ridge	8·82	Joss Cambier Wheat	5·19
The Holt	4·45	Joss Cambier Wheat	3·63
Bullrush	4·61	Cappelle Wheat	4·51
White Patch	9·14	Maris Ranger Wheat	4·17
Hackthorn	3·92	Maris Bead Beans	1·78

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Winter wheat was drilled on Brome Pin on 1 and 2 October, on Hackthorn on 22 October on the cultivated bean stubble, and on Dunholme following sugar beet on 6 to 9 December.

Beans. Maris Bead tick beans were drilled on 24 and 25 March on a poor seedbed. Simazine sprayed four days later controlled weeds without damaging the beans. Although the crop appeared to grow well and was worked by six hives of bees, it yielded poorly. Aphid control was unnecessary.

Fodder crops. The Italian ryegrass and clover ley on Brome Pin was irrigated during a dry spell in mid-April and was cut for silage during the third week of May. It was immediately top-dressed with 150 kg/ha N and given 50 mm of irrigation to yield a hay crop early in July. The ley under the barley on Little Lane was rather patchy but filled in well after the barley was harvested.

Sugar beet. The basic fertiliser on Dunholme was 750 kg/ha of kainit applied in the autumn and 720 kg/ha 20 : 10 : 10 compound on the seed bed. New Piece had 750 kg/ha kainit and 375 kg/ha 0 : 20 : 20 compound in the autumn and 440 kg/ha 'TN 34' fertiliser (34·5% N) at drilling. Drilling started on 23 March and continued in good conditions until 7 April, leaving only 1·21 ha of experiments requiring late drilling. Seventy-five per cent of the crop was sown with pelleted monogerm seed and half the area was spaced at 13 cm or more and a quarter between 6 and 13 cm; the remainder was sown with rubbed and graded seed at close spacing. Most of the crop was band sprayed with 'Pyramin' at drilling. 'Betanal E' sprayed on part of the crop after emergence damaged the beet and did not control weeds as well as in previous years. All the crop was sprayed with insecticide to protect it from yellows. Harvesting started on 28 September and continued, mostly in good conditions, until it finished on 10 December. Deliveries to the factory continued into January. Yields averaged 38·9 t/ha of clean roots at an average sugar content of 17·1% ranging from 15·8% to 18·4%. Mean dirt and top tares were 87 and 51 kg/t. The country's average yield this year was 43·5 t/ha of roots at 16·6% sugar.

Livestock. During October 1970, 75 Hereford cross steers at an average liveweight of 260 kg were bought for fattening. They were fed silage *ad lib*, hay when the silage was finished, restricted concentrates and fresh straw and mineral licks on offer at all times. They also had 10 t potatoes because both silage and hay were scarce. The concentrate ration was supplemented with protein at first but was basically 50% rolled barley and 50% sugar beet pulp to a maximum of 5·4 kg/head/day. The average liveweight gain was 0·70 kg/head/day and the average selling liveweight between 15 April and 22 June was 404 kg. Forty steers and 30 heifers were bought in October 1971. (Golding)

Staff and visiting workers

Dr. S. Zsembery of the Department of Plant Protection, Budapest Agricultural University, Hungary, worked for three months at Broom's Barn during the tenure of an FAO Fellowship. A Sandwich Course Student, I. G. Purcell (University of Bath) was with us for six months.

R. Hull organised a symposium on Integrated Control of Pests and Diseases of Sugar Beet at the winter congress of the International Institute of Sugar Beet Research in Brussels to which R. A. Dunning, G. D. Heathcote and W. J. Byford contributed. A. P. Draycott contributed to the International Soil Science Society meeting in Israel

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and visited research stations and sugar-beet growing areas. R. Hull attended a working group meeting on yield and quality determination in field experiments in Vienna. G. D. Heathcote organised a session on virus and mycoplasma diseases of plants and their chemical control at the Sixth British Insecticide and Fungicide Conference at Brighton, where R. A. Dunning and G. H. Winder contributed papers.

A symposium was held at Broom's Barn in June to discuss the importance of chemical quality determinations on sugar beet from field experiments. The British Sugar Corporation Agriculturists came for a two-day discussion forum in June. About 350 people attended an Open Day on 15 July. Among groups of visitors we welcomed on other occasions were Essex Agricultural Executive Committee, Directors of Agricultural Advisory Services to OECD Countries, National Farmers' Union members from Worcestershire, Hereford and Wisbech, Danish farmers and agriculturists from Indian sugar factories.

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