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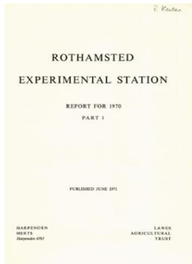
ROTHAMSTED
EXPERIMENTAL STATION
REPORT FOR 1970
PART 1

Broom's Barn Experimental Station

R. Hull

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BROOM'S BARN EXPERIMENTAL STATION

R. HULL

The field experiments at Broom's Barn help to explain some experiences of growers with sugar beet in the unusual weather of 1970. The soil was too wet to allow much sugar beet to be sown in March and rain in April further delayed drilling. However, in this cold spring, early sowing did not give its usual benefits, and sowings at the end of April yielded as much as sowings at the end of March, although later ones yielded less. Also, seedbed preparations during March compacted the soil and restricted growth. Late sowings gave seedlings that grew quickly and seedling pests and diseases were less destructive than usual. Fewer seedlings were lost from *Aphanomyces* than expected with sowing late in warm soil, but its spread was restricted by lack of moisture. For unknown reasons roots did not penetrate as quickly as in the previous two years and the consequence was seen in lack of growth when soil moisture became deficient during the summer. Doubtless for this reason, crops responded to more nitrogen fertiliser than usual. When the roots penetrated deeply during the autumn, they continued to extract water from depth although rain had then wetted several inches of top soil. The crop responded well to irrigation during summer.

Aphid infestations were controlled by sprays and, in spite of winged aphids sometimes being abundant, sugar beet remained free from yellows until autumn. Powdery mildew became prevalent in late summer and doubtless affected yield.

Seedling pests and disease

Pitfall trapping. Four pitfall traps of the type described last year (p. 312) were placed in each of five sugar-beet crops, on different types of soil, approximately ten days after sowing. Two, 35 ft apart, were near the centre of the field and two at least 40 ft from the headland. The traps were emptied weekly from 5 May until 4 August on the clay, sand and light peat sites and until October on the chalk and silt. The sand, chalk and silt sites proved to be of special interest because serious damage from pests occurred there.

The millipede *Boreoiulus tenuis* attacked the seedling beet on the chalk early in June but was not caught in the traps; nor was *Blaniulus guttulatus* which was present, but a few *Brachydesmus superus* were.

Pigmy beetle (*Atomaria linearis*) were trapped on all sites, but most, up to 43/trap/week, were trapped on the silt during May, coincident with observed damage to the roots. After spraying with DDT, the catch declined from an average of 12/trap/week to 3/trap/week. A few millipedes, *B. superus* and *Polydesmus gallicus*, were caught (up to 4/trap/week) during May and June on this site, and *B. superus* were active on the soil in September and October when up to 29/trap/week were caught.

Sand weevils (*Philopedon plagiatus*) were trapped, 10/trap/week during the first week of May on the sand site; after spraying with DDT fewer were trapped. The garden chafer (*Phyllopertha horticola*) and pigmy beetle (*Atomaria linearis*) were trapped in mid-June.

Carabid beetles were caught on all sites, with *Bembidion lampros* the predominant species in April–May. *Feronia* spp. appeared first in mid-June and were most numerous in August, as at Broom's Barn in 1969; they were most abundant on the clay and the silt with catches up to 68/trap/week. Up to 7/trap/week were trapped on the fen but none on the sand site.

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Although the beet was sown at approximately the same time on each field, seedlings established and grew at very different rates; the resulting differences in temperature, light and humidity below the leaf canopy may have affected the activity of pests. (Dunning and Baker)

Soil pest biology. At the trapping site on chalk soil, millipedes were especially prevalent at the foot of the slope where the seedlings were stunted and the stand thin. Soil samples 2 in. diameter and 6 in. deep centred on seedlings in the area contained an average of 41 *B. tenuis* and three *B. guttulatus* per seedling in contrast to only one *B. tenuis* per seedling where the beet were more vigorous. Two extra traps put in the infested area did not trap the millipedes responsible for damage at this time, but trapped some in late September. From June to October two traps caught three times as many Carabid beetles (*Feronia* spp. plus *Trechus* spp.) and twice as many Arachnids as in the area where the beet were more vigorous.

To test the millipedes' attraction to bait, sections of rotting potato in a 6 in. × 4 in. perforated zinc basket were buried in the soil in the infested area; within three days the bait contained 200 *B. tenuis* and 50 *B. guttulatus*. Boiled tick bean, barley and wheat, enclosed within buried 3 in. × 1 in. perforated zinc tubes, were also suitable baits provided they did not become mouldy. The baits caught most millipedes in parts of the field where seedlings were fewest. Millipedes were fewer in soil core samples taken where tractor wheels had compacted the soil during seedbed preparation, and aerial photographs clearly showed how this had improved the growth of the plants.

The crops on a peaty loam at March, Cambs., and at the pitfall-trapping site on silt soil, were damaged by pigmy beetle. Soil samples taken when the pest was active (18 May and 2 June respectively) showed that almost all the beetles were in the beet rows, aggregated around hypocotyls and roots. In the peaty loam there was an average of 8·6 beetles in the soil around each seedling but only 0·1 in the row between the seedlings and even fewer between the rows; because of the damage the plant stand was only 18 000/acre.

The flat millipede, *B. superus*, was caught in pitfall traps on the silt soil in May, June, September and October, when it could also be found readily under decaying leaves and in the moist soil around beet plants. None was trapped in July and August. On the soil surface beneath old beet leaves at the end of October there was an average of 6·1 millipedes/6 sq in. and soil cores adjacent to beet plants gave an average of 5 600 000 millipedes and 600 000 pigmy beetles/acre.

The numerous flat-millipedes on the soil surface during the autumn prompted a survey in beet fields in different sugar-factory areas. *B. superus* was by far the most prevalent, and *P. gallicus*, *Ophyiulus pilosus* and *Cylindroiulus* spp. were found occasionally.

On heavy peat soil at Seventh Drove, Ely, pitfall traps were used to study movement of millipedes on the soil surface and the effect of spraying gamma BHC (1 lb a.i./acre) on the seedbed. *B. superus* were common in the soil during February, especially where straw was ploughed in, and there were 200 000/acre in the seedbed during April. Samples taken around the beet seedlings at the end of May contained two other species, *B. guttulatus* and *Macrosternodesmus palicola*. Potato tuber baits attracted both *B. superus* and *B. guttulatus* but only *B. superus* was caught in the pitfall traps, most during May. *B. guttulatus* increased on the baits until early June, when they formed half the total millipede catch, but the next week millipedes had gone and baiting was discontinued. On the silt soil many *B. superus* were trapped during September, but none on the heavy peat soil from August until October. Samples of the peat contained pigmy beetle during May and these were caught in pitfall traps from April until October, most in May, June and July, and few in September. In October there were many dark coloured adult as well

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as light, immature beetles. Untreated plots had a third to a half as many as the BHC-treated plots. Soil sampling at other sites indicated that gamma BHC decreased numbers of pygmy beetle and of *B. tenuis*.

Symphylids (*Scutigerella immaculata*), aggregated and damaged the seedlings on a heavy silt soil at North Lynn, Norfolk; there was an average of 2·6/soil core centred on a seedling but only 0·2 in the row between the seedlings. Wilted seedlings had many symphylids in their root zones, with the hypocotyl pitted or severed, and lateral root tips excised.

Different *B. superus* stadia and adult *B. tenuis* and *Archeboroiulus pallidus* damage especially the emerging radicle tip of the germinating seed and sometimes damage the hypocotyl by small punctures through the cortex. Millipedes damaged seedlings at 15° and 22°C but only occasionally at 4°C. *B. tenuis* collected from the field when they were damaging beet were placed in uncompacted soil in a box along with germinating seedlings growing against the perspex sides; they aggregated in the root zones. A single millipede completely severed a hypocotyl in 3 hours at approximately 22°C. Putting an alternative food supply for *B. superus* in the box (e.g. rotting beet leaves), increased the number of unharmed seedlings. Weak sugar solutions, especially 5% sucrose, added to either filter paper or water–agar attracted *B. superus* and elicited a biting response. (Baker)

Seed and soil treatment with insecticide. Sixteen trials in different sugar-factory areas tested various insecticides and fungicides incorporated during pelleting of Amono monogerm seed. Dieldrin at 0·1 to 6·4% by weight of seed, did not affect laboratory germination either soon after pelleting or six months later. Three trials were drilled late in March, the others between 17 April and 4 May. Seedling numbers were, on average, 50% of the numbers of seeds sown but ranged from 24 to 71%. Some treatments increased seedling numbers significantly at some sites; on average, all increased numbers of seedlings but not significantly. All amounts of dieldrin, except 0·2%, increased the plant stand.

At three sites selected because beet had previously been damaged by soil pests, the seed pellets incorporating dieldrin were compared with 0·2% dieldrin + 5% P_2O_5, 0·8% 'Dursban', 0·8% heptachlor and 0·8% mecarbam. Half of each plot was sprayed during seedbed preparation with 1 lb γ BHC/acre before sowing in late April. Small populations of pigmy beetle and *Onychiurus* occurred in the seedling root zone at all sites, and millipedes at two. BHC spray slightly increased seedling numbers, but the commercial rate of seed dressing, 0·2% dieldrin, increased seedlings by 12% and plants by 4%; greater amounts were less beneficial and 6·4% tended to be harmful. Heptachlor, and especially 'Dursban' and mecarbam, decreased seedling and plant stands on average. At Seventh Drove, Ely, millipede feeding lesions (2/plant on average) were obvious on 55% of the untreated plants and pigmy beetle lesions (5/plant) on 92%. Dieldrin seed dressing (0·2%) with γ-BHC seedbed spray decreased the number of millipede lesions per plant, as did 0·8% 'Dursban' seed dressing alone. The same treatments significantly decreased the proportion of plants with feeding lesions of pigmy beetle and, together with 0·8% heptachlor, the number of lesions per plant. At two of the sites subsidiary trials compared aldicarb granules at 10 oz a.i. in the seed furrow with liquid formulations of fenitrothion ('Accothion'), propoxur, γ-BHC, carbaryl, DDT, 'Dupont 1410', 'Dursban', fenthion, heptachlor, mecarbam and methiocarb at 1 and 10 oz a.i./acre. The greater amounts of γ-BHC, fenthion and mecarbam decreased seedling and plant numbers; no treatment increased seedlings significantly but 10 oz DDT and 1 oz fenthion increased plant population. Millipede and pigmy beetle root damage was at least halved by aldicarb granules and by DDT, 'Dursban' and heptachlor solutions, all at 10 oz a.i./acre, and by fenthion at 1 oz a.i./acre.

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On peat soil at West Row Fen, Ely, many dead millipedes (*Cylindroiulus punctatus*) were found on the soil after placing aldicarb granules with the seed at approximately 8 and 32 oz a.i./acre; 'Dupont 1410' did not have this effect. (Dunning and Winder)

When sugar-beet seed pelleted by the Germain process was stored at about 18°C for long periods, germination was impaired only very little more with menazon incorporated in the pellets than without. For example, sown in heat-treated compost in the glasshouse during March 1970, 76% of Sharpe's Klein E seeds pelleted during February 1968 without menazon produced seedlings compared with 71% of similar pellets containing 6% menazon. Similarly, after storage for one year, 44% of pelleted Amono and Monotri monogerm seed without menazon produced seedlings when sown during March 1970 and 43% of the pellets with 4% menazon incorporated. (Heathcote)

Beet leaf miner and other foliage pests. On silt soil at Holbeach St. Marks, 8, 16 and 32 oz a.i./acre of aldicarb granules drilled with the seed prevented *Pegomya betae* larvae from mining the foliage for 34 days after drilling; control was failing 57 days after drilling. On peat soil at West Row Fen, plants on plots treated with 16, 32 and 72 oz aldicarb a.i./acre were free from beet leaf miner 64 days after drilling, but not those given 8 oz a.i./acre. At 8 oz a.i./acre, 'Dupont 1410' solution was less effective than aldicarb, but equally effective at 32 oz a.i./acre.

At Holbeach, black aphids were fewer 57 days after sowing with all amounts of aldicarb drilled with the seed than without, and green aphids with all amounts except 4 oz a.i./acre.

At Barton Mills, Suffolk, there were 41% fewer plants with leaves rolled by Tortrix caterpillars (*Cnephasia interjectana*) and 75% fewer plants 'blinded' by *Lygus* where aldicarb granules (15·4 oz a.i./acre) had been drilled with the seed 57 days earlier. (Dunning and Winder)

Seedling diseases and fungicide seed treatments. The dry weather after drilling in May curbed *Aphanomyces cochlioides* and only seven samples of infected seedlings were received compared with 14 in 1969 when the soil was both warm and wet.

A trial on peat soil where beet was severely damaged in 1969 compared fungicides for controlling *A. cochlioides*, using pelleted seed. Seedlings emerged irregularly because of the drought and only 11% of seedlings had blackleg at singling time. 'Dexon' on the seed (6·9 g a.i./kg), as a liquid at drilling (1·1 and 2·2 kg/ha) and as granules (6·7 kg/ha) at drilling gave 2, 3, 1 and 0% seedlings with blackleg respectively. Ineffective treatments were dichlone at 2·3 g a.i./kg and 'Dexon' on the seed at 4·9, maneb in the pellet (13·2) or as a slurry before pelleting, dichlone, quintozene, thiram and maneb (2·2 kg a.i./ha) and benomyl (1·1) all applied to the soil as liquids at drilling. All seed was EMP steeped except when treated with maneb, and all was treated with 0·8 g/kg dieldrin. No treatment increased seedling emergence, and the larger amounts of 'Dexon' granules and liquid were damaging and gave 17% fewer seedlings than the control. The final plant stand was very irregular and at harvest the only treatments yielding more than the control were maneb dust in the pellet and 'Dexon' as a liquid at 2·2 kg a.i./acre, which gave 5 and 6% more sugar/acre respectively.

In September, fieldmen from the Ely area supplied 35 soil samples from randomly selected fields. Seed was sown in these soils and kept warm and moist in the glasshouse. Seedlings that damped off gave *A. cochlioides* in 14 soils including 12 of the 14 peats.

In 16 field trials (see p. 250) EMP steeped seed treated during pelleting with 4·6 g a.i./kg dichlone, 'Dexon' (4·6 or 6·9), and untreated seed with maneb (13·2) in the pellet or as a slurry before pelleting were compared with EMP steeped seed. All seed was treated with dieldrin (0·8). None of the treatments gave, on average, significantly better

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seedling emergence or final stand than EMP steep alone, and at no site did seed treated with protectant fungicides give better seedling emergence and plant stand than seed treated with EMP steep and dieldrin. Maneb slurry applied before pelleting gave emergence and final stands similar to EMP steep. In another trial at Broom's Barn none of the above treatments gave better emergence, final stand or yield than EMP steep alone; ethirimol at 32 g a.i./kg seed slightly decreased emergence and final plant stand, and did not decrease the incidence of powdery mildew in September and October. In the glasshouse this material as a seed dressing kept plants free from powdery mildew for at least 15 weeks after sowing, by when control plants were severely infected. It did not prevent downy mildew when seedlings at the cotyledon stage were artificially inoculated. (Byford)

Yellows and aphids

February was colder in eastern England than average (−0·7°C) and March more so (−2·4°C), with more days with frosts than any March for at least seven years. This indication from the weather that yellows was unlikely to be severe in 1970 was realised, although the summer was favourable for aphids. Mean incidence of yellows in English sugar-beet crops at the end of August was 3·8%. Fewer than 1000 acres were reported with more than 60% infected plants and 316 000 out of 426 000 acres had fewer than 1% infected plants. The numerous aphids flying during July and August spread yellows which began to show in some areas during September, too late to affect yield seriously. Because the summer weather was so favourable for aphids, and crops more susceptible than usual because they were sown late, sugar factories issued spray warnings as soon as aphids were detected on sugar beet. Warnings issued specifically for green aphids were few, but more were given for black aphids, mostly early in July. About 230 000 acres were treated once with insecticide and 54 000 acres twice.

Aphids infesting clamped mangolds and weeds. Fieldmen from the sugar factories examined 411 mangold clamps for aphids during late April; 54 were infested (a similar proportion to 1969) but only three heavily. Some aphids from three of 25 clamps were infective with BMYV, from three clamps with BYV, and from two clamps with both viruses.

Fieldmen submitted 88 samples of chickweed, groundsel or shepherds' purse, collected alongside fields where beet was grown in 1969. They were asked to seek plants showing symptoms. Only four samples were infested with *M. persicae*, but ten contained plants infected with BMYV. Other weed species collected by fieldmen were free from viruses that infect sugar beet. Common mallow, *Malva sylvestris* L., was infected experimentally with BMYV, but not with BYV.

Aphid traps. Eight sticky traps caught on average fewer aphids than during 1969; more *Brevicoryne brassicae* were caught than for several years. Although more *M. persicae* were trapped than during 1969, they were few in May and June. Nearly as many *A. fabae* were trapped as during 1969, but most were caught in August, two weeks later than in 1969.

Coccinellids were unusually abundant in eastern England. On average, 61 ladybirds were caught per sticky trap compared with 17 per trap in 1969. Many 7-spot ladybirds were seen on the Suffolk shore early in August, and aggregating on bushes near Brandon, Suffolk, early in November.

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Aphids and diseases in seed crops. Samples of leaves and shoots from about half of the 274 seed crops grown in Britain were checked for infesting aphids in late May, June or early July. There was no evidence that many green aphids overwintered on any beet-seed crops. Black aphids were first found during early June. Most colonies developed slowly but, in Lincolnshire, they increased rapidly during early July. (Heathcote)

In June, 86 sugar-beet seed crops distributed in all seed growing areas had an average of 0·3% plants with yellows, and 11 mangold seed crops in Lincolnshire averaged 1·5%. No crop was extensively infected. Plants with downy mildew were few and the disease was recorded in only one mangold seed crop. Yellows was scarce in sugar-beet steckling beds in October, when 145 beds averaged 0·02% infected plants. Downy mildew was not recorded. Eight mangold steckling beds averaged 0·18% plants with yellows. (Byford)

***Aphis fabae* survey.** In 1970 we co-operated with Professor M. J. Way and Mr. M. Cammell of Imperial College and others in attempting to forecast *A. fabae* outbreaks after assessing eggs in December and January, and peak populations in spring on spindle bushes. Colonies were checked on spindle bushes at 15 sites in west Suffolk and south-west Norfolk. Eggs or larvae were many fewer than on the same bushes in 1969. The light infestation of *A. fabae* predicted in this area was generally fulfilled. Sugar-beet crops in the Spalding and Nottingham areas were heavily attacked by *A. fabae*, but spindle bushes were not examined there. No spring migrant was caught in water, sticky or suction traps until the first week of July at Broom's Barn, where neither spring beans nor sugar beet became heavily infested. The population declined rapidly early in August, when predators were unusually abundant. Three times as many coccinellids were trapped at Broom's Barn as in 1969.

Aphid control with insecticide. Preliminary tests were made of a hand held battery operated spinning disc applicator for applying concentrated aphicides. The distribution of droplets was checked using fluorescent tracers. Early in August untreated sugar beet had five times as many *A. fabae* as plants sprayed with 8 pints/acre of 1% dimethoate in oil ($\frac{1}{10}$ the recommended rate for dimethoate applied in 20–100 gal of water/acre). The ultra low volume spray did not cover the youngest beet leaves and aphids survived on them. Droplets were more evenly distributed over field beans, but *A. fabae* were too few to test the sprays. (Heathcote)

A field heavily infested with aphids at Sprowston, Norfolk, was used to compare

TABLE 1

Aphid numbers 4 days after spraying with insecticide

Treatment	No. of aphids/plant (Log $n + 1$) *Aphis fabae*	*Myzus persicae*
Untreated	2·777	1·004
Demephion 0·094% in water 3·6 oz a.i. in 24 gal/acre	0·533	0·174
Demephion 1% in oil 3·6 oz a.i. in 2·26 gal/acre	0·442	0·000
Demephion 1% in oil 0·72 oz a.i. in 0·45 gal/acre	0·596	0·112
Demephion 0·2% in oil 0·144 oz a.i. in 0·45 gal/acre	2·184	0·648
Least significant difference $P = 0·05$	0·427	0·209
0·01	0·599	0·293

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conventional aqueous demephion (methyl-demeton-methyl) with oil-based formulations. All sprays were applied along the rows from a few inches above the foliage so as to give full cover; to avoid drift effects, suitable discards were left between the treated plots. The aqueous spray was applied from a knapsack sprayer with a flat fan jet giving a wide range of droplet sizes, the oil sprays from the disc applicator giving a narrow range of droplet sizes, about the optimum for impinging on the foliage. Table 1 gives details of treatments, and shows that the oil-based demephion given at 0·72 oz a.i./acre was as effective as the aqueous spray at 3·6 oz a.i./acre. (Winder)

Influence of cultural practices. Only those areas of the sugar-beet crops at Broom's Barn where aphids had been introduced to infect plants with yellows were sprayed with insecticide. Yellows became prevalent late in summer on some experiments and the treatments the plots had received influenced the aphid infestation and spread of yellows. In an experiment on spacing and irrigation, 24% of the plants spaced at 40 in. × 20 in. had BMYV, but only 3% of the plants spaced 20 in. × 20 in. Yellows incidence did not differ between irrigated and unirrigated plots.

In a test of row width and plant population, significantly fewer plants showed yellows (BMYV) in plots with 20 in. between the rows than in plots with 30 in. between the rows (7·1 : 13·5% ± 0·52); the number of plants per unit area was also significantly smaller (200 : 240 plants/acre ± 7). Significantly more plants showed mild yellows at the end of August in plots without N than in plots given 120 or 180 units N/acre (351 : 119 : 123 plants/acre ± 56).

In another experiment only 4% of the plants were infected with yellowing viruses, and the incidence was similar in plots sown on different dates or given different amounts of N fertiliser. In July and August most aphids were on the plants sown in April. Samples of plants were removed from some plots during the growing season, leaving a few plants in gaps in an otherwise uniform crop; 17% of these became infected with BMYV, i.e. four times as many as in plots with unbroken rows. (Heathcote)

Varieties. One, three or ten apterous *Myzus persicae* that had fed on sugar beet with BYV were placed on sugar beet of three varieties sown in Hackthorn field on 1 May. The varieties were Bush Mono, which the National Institute of Agricultural Botany list as yellows tolerant, US H7A and the yellows tolerant variety developed from it US H9B, now extensively grown in California (kindly supplied by the breeder, Dr. J. Macfarlane, United States Department of Agriculture, Salinas). Half the plots infested with aphids were sprayed with insecticide. Ten days later, aphids were few on sprayed or unsprayed plots and there was no indication that one variety favoured their multiplication more than another. Yellows developed towards the end of June and by early July about 60, 82 and 97% of plants receiving 1, 3 and 10 aphids respectively showed symptoms.

Samples of plants examined in late July and late August showed that infection decreased the weight of overground parts and leaf area of Bush Mono more than of the American varieties. However, the root weight of Bush Mono, especially without yellows, was greater. In November the average sugar yield of all varieties without aphids was 54 cwt/acre compared with 10 aphids/plant 49 cwt/acre. On uninfested plots Bush Mono yielded 63 cwt/acre and the two American varieties 51 and 48 cwt/acre. These varieties are evidently not suited to the English climate; in August powdery mildew (*Erysiphe* sp.) became prevalent on them and caused considerable loss of leaf, but affected Bush Mono little.

In a similar experiment at Davis, California, testing only US H7A and US H9B,

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one, three and ten aphids gave 38, 67 and 86% infected plants. US H9B yielded on average 5200 lb/acre of roots more than US H7A whether infected with BYV or not. When healthy the mean yield of the two varieties was 36 ton/acre and about 29 ton/acre with yellows. The two experiments gave no evidence of any variety having greater resistance to BYV than another, but showed that one variety was better than another in the different environments, whether infected with BYV or not. (Hills and Hull)

Effect of yellows on roots. Two experiments examined the effect of BYV on varieties US H7A and US H9B growing with their roots in nutrient mist culture. On average, infection halved the fresh weight of tops of both varieties and decreased the fresh weight of their roots by 64% one month after infection. The top weight to root weight ratio for healthy plants was 1·58 and for infected 1·88. Both varieties had tap roots of similar length when healthy, but US H9B had longer ones than US H7A when infected.

Infecting seedlings with their roots in mist culture with BYV shortened their tap roots within seven days; the tap roots extended little for the next seven days but then until day 32 their extension rate approached that of uninfected plants, giving the relative length of healthy to infected of 3 : 2. Two weeks after infection effects showed on leaf size and the difference became gradually greater. At 24 days after infection the ratio of dry weight of healthy to infected tops was 3 : 2 and roots 2 : 1; after 32 days, the ratios were 2 : 1 and 3 : 1. Infection affected the total weight of roots relatively more than it shortened the tap root. (Hull)

Transmission of BYV and BMYV by aphids. The age of leaves from infected sugar beet on which apterous *M. persicae* fed affected their ability to transmit BYV and BMYV differently. Both viruses were transmitted readily from old leaves, but whereas BYV was transmitted more readily from young than old leaves, BMYV was not transmitted from young leaves. (Heathcote)

Leaf diseases

Downy mildew. Few plants became infected with downy mildew in either root crops or seed crops. The susceptibility of different sugar-beet varieties to the disease was again compared in co-operation with the National Institute of Agricultural Botany at their Regional Centre at Trawscoed, Cardiganshire, in a field where the fungus was artifiically inoculated to some plants. The wet spring delayed drilling until 22 May. The disease at first spread very unevenly but later became widespread, with the proportion of plants of different varieties that became infected ranging from 14% to 45%. The order of susceptibility was as in other years; varieties with fewest infected plants were Amono, Sharpe's Klein Polybeet and Anglo Maribo Poly, and with most Hilleshog and Bush Mono.

Single rows of five varieties were sown in several root crops in the seed crop areas of south Lincolnshire, west Norfolk and Cambridgeshire, but no mildew was found in any of them.

***Ramularia* leaf spot.** An open direct-drilled seed crop at Stonesfield, Oxfordshire, was used to study the effect on leaf spot of spraying with fentin hydroxide or benomyl between 7 May and 3 June. The percent leaf area covered with spots was estimated on 100 mid-stem leaves/plot on 23 July and the crop was harvested on 27 August. *Ramularia* spread rapidly during July in unsprayed but not in sprayed plots. One spray with benomyl at 0·28 kg a.i./acre was as effective as three sprays with fentin hydroxide at 0·67 kg a.i./

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acre, which gave not more than 0·2% leaf area covered by spots compared with 7·6% on leaves from unsprayed plants. With one or two sprays of fentin hydroxide at 0·67 kg a.i./ha, and one spray at 1·34 kg, 0·9, 0·8 and 0·5% leaf area was covered respectively. However, the only treatment that increased yield of seed, by 4%, was one spray with fentin hydroxide at 1·34 kg a.i./ha.

At Pointon and Sutton St. James, Lincolnshire, in two seed crops grown on *in situ* from 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 7 May and 4 June. *Ramularia* was too slight on unsprayed crops to assess the effect of spraying, but at Great Staughton, where powdery mildew was widespread and severe in unsprayed plots, this disease was controlled by the sprays, and one, two or three sprays increased seed yield by 9–10%. At Pointon sprays did not affect yield, but at Sutton St. James, for unknown reasons, one spray increased yield by 11%, two sprays by 7% and three sprays by 2%.

Late summer fungicide sprays. To study the possible effects on leaf survival and senescence of controlling leaf pathogens in 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 on sugar beet at Broom's Barn at fortnightly or monthly intervals from 22 July to 25 September. Both upper and lower leaf surfaces were sprayed. Leaves examined on 15 October showed powdery mildew, rust, *Ramularia* leaf spot, *Phoma* leaf spot, *Alternaria*, and lesions probably caused by bacteria, but only powdery mildew was prevalent enough to allow its severity to be estimated. Almost every leaf of unsprayed plants in parts of the trial had mildew, but all sprayed plants were free from it. However, sprays did not increase root weight or sugar content. They increased top weight on average by 9%. Monthly sprays increased tops by 12% and fortnightly ones by only 6%, suggesting that frequent spraying damaged the plants. (Byford)

Violet root rot

Attempts to control *Helicobasidium purpureum* were made in a field where, in 1969, a severely infected carrot crop had been ploughed in. Fungicides were sprayed on the soil in a 25 cm wide band along the rows before drilling, and rotovated in to a depth of approximately 20 cm. Materials tested were (kg a.i./ha) mebenil at 11·2 and 16·8, benomyl at 6·7 and 11·2, 'Vitavax'/mercury at 6·7 and 11·2, quintozene at 11·2 and 22·4, thiram at 11·2 and nitrogen top dressing at 94 and 188 kg/ha N.

No treatment significantly affected seedling emergence or plant population. On 30 September plots with mebenil at 11·2 kg/ha had 25% infected roots, 8% less than in the untreated plots. All other treatments had less or no effect. Yield differences were not related to the proportion of diseased roots. By 2 December none of the treated plots had fewer infected plants than the untreated, and the average in the trial was 63%. Sugar yield was not increased by any treatment. Infection was unevenly distributed, but although plots had from 25% to 100% infected roots, the percent of diseased roots did not affect root yield. However, plots with fewer than 40% infected roots averaged 15·0% sugar, whereas plots with more than 80% infected roots averaged 13·7% sugar.

To investigate this difference further, roots were lifted from ten random 20 ft lengths of discard rows. After washing, the roots were graded as healthy; moderate infection (less than 50% of the root surface with lesions), or severe infection (over 50% of the surface with lesions). Severely infected roots weighed on average 14% less than healthy roots and, with a sugar content of 13·1% compared with 14·8% in healthy roots, con-

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tained 24% less sugar per root. However, moderately infected roots weighed 31% more than healthy roots and had a similar sugar content, hence the average sugar per root of infected and healthy roots was similar. (Byford)

Docking disorder

Survey. Only 520 acres were affected by Docking disorder at the end of June, mostly (450 acres) in the Selby factory area. This is the smallest acreage reported since accurate records have been collected, and resulted from the soil being very dry during May, conditions unsuitable for nematode activity; it contrasts greatly with the 19 320 acres affected after the wet May of 1969.

Over 1000 acres of sugar beet were treated with nematicides. There was little evidence that crops were harmed even when drilled on the same day as the fumigant was injected. However, both injection and drilling were often later than most years, so the soil was warmer than it would usually be. Treatment gave an even crop with improved root shape, but few large increases in yield because Docking disorder was rarely severe.

Of 53 sites surveyed where Docking disorder was expected, 41 had *Trichodorus* spp. (average 312/litre of soil) and 27 *Longidorus* spp. (average 47/litre of soil). The crops at only 11 of the sites showed Docking disorder in June and 10 of these recovered during the summer. The yield of unaffected crops averaged 15·9 tons of roots/acre and the other 13·6 tons/acre. The unaffected crops had a better root shape at harvest. (Cooke)

Viruses. The only virus found in stunted beet from 26 of the fields surveyed for Docking disorder was tomato black ring, and this in plants from only two fields. (Heathcote)

Injection methods. Two trials at Gayton Thorpe, Norfolk, compared injecting fumigants behind tines 8 in. deep with sub-soil spraying beneath horizontal blades set 8 in. deep. In the first, 8, 16 and 32 gal/acre 'Telone' were applied on 18 December when soil temperature at 8 in. was 32°F. Pure 'Telone' was used except for the spray at 8 gal/acre which was a 50% emulsion with water. Applied by the tine injector, these amounts killed 71, 83 and 90% of the *Trichodorus* in the surface 8 in. of soil; applied by the sub-soil sprayer they killed 96, 90 and 86%. Untreated soil contained 3287 *Trichodorus*/litre.

In the second trial, 'D-D' was used at 8, 16 and 32 gal/acre; the 8 gal/acre spray was a 50% emulsion in water; the 8 gal/acre injection behind tines was applied both as 100% 'D-D' and as a 50% emulsion; other amounts were 100% 'D-D'. Tine injection of 100% 'D-D' killed 70, 93 and 89% of the *Trichodorus* in the surface 12 in. of soil; applying 8 gal/acre emulsion increased the kill to 78%. As a sub-soil spray the increasing amounts killed 86, 93 and 95%.

Hence, relatively small amounts of fumigant can control *Trichodorus*, especially when well distributed by applying either as an emulsion or as a sub-soil spray. These trials were made in co-operation with the National Institute of Agricultural Engineering, where the sub-soil sprayer was built. (Cooke)

Row treatments with nematicides. At five sites prone to Docking disorder, nematicides were put only in the bands of soil into which the beet were to be drilled. Different amounts of 'D-D' and 'Telone' were injected behind tines 5–8 in. deep, either two weeks or immediately before sowing, or aldicarb (at 1 lb a.i./acre) was put in the furrow with the seed.

Table 2 shows the effect on *T. anemones* at different depths and distances from the row injected with 1 ml 'D-D'/ft at Raskelf, Yorks, where tines were set 5 in. deep.

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TABLE 2

Numbers of T. anemones/*litre of soil at Raskelf, Yorks, 8 weeks after treatment*

Depth (inches)	Distance from line of injecting 'D-D' 0 in.	5 in.	10 in.
0–3	8	42	200
3–6	83	1033	2550
6–9	1150	1417	2317

Number in untreated plots (0–9 in.) = 1244/litre soil

The little effect in the 6–9 in. zone was probably because the tines were set shallow. Control was good in the surface 6 in. of soil along the injected row but much worse only 5 in. from the injected row.

In three experiments in East Anglia, both aldicarb and 'Nitro-chalk' (17 units N/acre, applied a week after sowing in bands over the beet rows) killed about a sixth of the seedlings; 'D-D' at 2 ml/ft row applied immediately before sowing, killed up to a quarter of the seedlings and 'Telone' at 1·33 ml/ft row killed up to a sixth. Fumigation two weeks before drilling was not harmful.

Docking disorder did not occur in any of the experiments but drought, boron deficiency and weed infestations seriously affected growth of the beet, which yielded little. Aldicarb and nitrogen top dressing usually did not affect sugar yield, but 2 and 1 ml 'D-D'/ft and 1·33 and 0·66 ml 'Telone'/ft usually increased it, though not always significantly. 'Telone' did so most when applied immediately before drilling at 0·66 ml/ft (average increase 5·9 cwt sugar/acre), and 'D-D' when applied two weeks before drilling at 1 ml/ft (average increase 4·3 cwt). (Cooke, Dunning and Winder)

Nematicide trials. Aldicarb ('Temik 10GV') granules were drilled in the furrow with pelleted seed at Hockwold and Holt, Norfolk. The drilling dates and the numbers of *Longidorus* and *Trichodorus*/litre of soil at drilling were: Hockwold 10 April: 5, 0; Holt 25 March: 0, 1725. The soil at Hockwold is peat fen on sand pH 7·5, and at Holt, sand pH 7·3. Little rain fell after drilling and Docking disorder did not develop. At Hockwold aldicarb slightly decreased seedling numbers and post-singling plant populations, but it did not affect seedling vigour. At Holt treatments were duplicated and 'Nitro-chalk' was applied twice in a 3 in. band over the rows (14 units N on 16 April, 16 units N on 7 May). Aldicarb without the extra N had little effect on seedling numbers and slightly increased post-singling plant populations but, especially the larger amounts, decreased seedling numbers with the extra N. Seedling vigour increased with greater amounts of aldicarb, but N had little effect. At 0, 3·8, 7·5, 15·4 and 30·2 oz a.i./acre of aldicarb sugar yields at Hockwold were 39·0, 33·1, 37·2, 33·0 and 37·6 cwt/acre; at Holt 42·5, 45·9, 45·5, 43·7 and 44·6 without N, 44·0, 44·7, 43·4, 45·6 and 44·5 with N (no significant differences). Aldicarb did not affect root shape at Hockwold but at Holt improved it; as previously, nitrogen top dressings had no effect on root shape.

A similar trial tested aldicarb granules drilled in the furrow with the seed on 2 May on a site not prone to Docking disorder at Broom's Barn. The soil is clay loam, and free from *Longidorus* and *Trichodorus*. Aldicarb slightly decreased seedling numbers, post singling plant populations and vigour, except at 10 oz/acre, which increased them. Sugar yields were 63·5, 57·3, 61·2, 62·2 and 59·9 cwt/acre at 0, 5·0, 10·0, 20·6 and 42·8 oz a.i./acre respectively. Root shapes were worse on the treated plots (significant at $p = 0·05$ for 5·0 oz a.i./acre).

At Holt, Norfolk, and Sutton, Suffolk, nematicides were placed in the furrow with the seed, in single row plots with untreated rows between. Solutions of 'Dupont 1410' at

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2, 8 and 16 oz a.i./acre and thiabendazole, methomyl, thionazin and benomyl each at 2 and 8 oz a.i./acre, all at 32 gal/acre, and aldicarb granules at 7·5 oz a.i. were tested at both sites; also Plant Protection 'JF 2965' and 'JF 2966' granules at 8·3 and 7·1 oz a.i./acre respectively at Sutton.

At Holt all treatments decreased seedling numbers, 'Dupont 1410' (8 and 16 oz a.i.), thiabendazole (8) and thionazin (8 and 16) significantly ($p = 0{\cdot}05$). None of the treatments significantly affected plant numbers, vigour and yield; 'Dupont 1410' (8 and 16) improved root shape significantly.

At Sutton, thiabendazole (8), methomyl (8) and thionazin (8) significantly decreased seedling numbers, from 6·27 to 4·92, 4·73 and 2·95, and decreased seedling vigour. Methomyl and thionazin gave fewer plants after singling and decreased yield from 29·3 cwt to 16·7 and 14·1 cwt/acre respectively, and thionazin worsened root shape significantly.

Pelleted Amono seed incorporating thionazin, methomyl, thiabendazole and 'Dupont 1410' at 0·5% a.i. by weight of unpelleted seed, and isobutyridene diurea at 1·25% N by weight of unpelleted seed, were tested at Hockwold and Little Cressingham, Suffolk. At Hockwold, thionazin and 'Dupont 1410' decreased seedling populations significantly. All treatments decreased yield, although sugar content was not affected, from 39·9 to 37·0, 35·9, 34·7*, 35·4* and 38·0 cwt sugar/acre. At Little Cressingham all treatments tended to increase seedling numbers, 'Dupont 1410' significantly. Docking disorder did not occur, but yields were very small (3·75 tons/acre on the untreated control) and treatments tended to decrease them. (Dunning and Winder)

Large-scale trials. The effect on nematodes of fumigants injected behind tines spaced 20 in. or 10 in. apart was assessed on two of a series of Docking disorder trials organised by the Sugar Beet Research and Education Committee. At Westleton, Ipswich, 'D-D' at 1 ml/ft row from tines 20 in. apart was compared with 1 and 2 ml/ft row from tines 10 in. apart. At Larling, Thetford, 'Telone' at 0·67 ml/ft row from tines 20 in. apart was compared with 0·67 and 1·33 ml/ft row from tines 10 in. apart. Soil samples were taken along the beet rows 2–3 months after fumigation and nematode control determined (Table 3). *Trichodorus* were few at both sites and were eliminated by all treatments except

TABLE 3

Nematode control by soil fumigation

		Tine 20 in. apart		Tine 10 in. apart			
	Untreated No./litre	No./litre	% of control	No./litre	% of control	No./litre	% of control
		1 ml/ft row		1 ml/ft row		2 ml/ft row	
Westleton*							
Tylenchorhynchus	1394	350	25	113	8	63	5
Pratylenchus	250	144	58	138	55	106	43
Trichodorus	19	6	33	0	0	0	0
Other *Dorylaimida*	700	213	30	94	13	25	4
		0·67 ml/ft row		0·67 ml/ft row		1·33 ml/ft row	
Larling†							
Tylenchorhynchus	1463	106	7	62	4	19	1
Pratylenchus	138	38	27	56	41	25	18
Trichodorus	44	0	0	0	0	0	0
Other *Dorylaimida*	619	106	17	38	6	25	4

* Fumigant—'D-D'
† Fumigant—'Telone'

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with the least 'D-D'. A greater proportion of *Tylenchorhynchus* was killed than of *Pratylenchus* at both sites. All nematodes were controlled better at Larling than Westleton, probably because soil conditions were more favourable at the time of injection. (Cooke)

Cyst eelworm

Aldicarb and 'Dupont 1410' were tested at a site in West Row Fen, Suffolk, infested with *Heterodera schachtii* (see *Rothamsted Report for 1969*, Part 1, 322). The field last grew beet in 1966 and the peat soil contained 15 eggs and larvae/g in March 1970. Aldicarb granules, drilled with the seed at 7·5, 15·1, 30·8 and 60·4 oz a.i./acre, decreased seedling numbers but had no effect on plant stands and vigour. Although white cysts were found on the roots, the beet apparently suffered little harm; yield was not affected by 7·5 oz a.i./acre but was slightly diminished by the larger amounts. (Dunning and Winder)

Seed production

Factors affecting seed yield

Sowing date, fertilisers and harvest date. Plots sown at Stonesfield, Oxon., on two dates in 1969, with or without sodium chloride, received various amounts of P_2O_5 and N as top dressings during the spring and were harvested on three occasions in the autumn. Yields comprise all seed recovered by an inclined moving belt from a winnower after passing through 8·75 mm and over 2·50 mm round hole sieves, corrected to 15% moisture content and 97% purity. Only sowing date significantly affected plant populations. Plots sown on 8 July established 534 000 plants/ha of which 91% survived, whereas plots sown on 25 August established 459 000 plants/ha with 71% survival. All populations were dense enough not to limit seed yield, which averaged 3770 kg/ha. The early sowing produced 89% more seed than the late. Salt at 375 kg/ha in the first and 125 kg/ha P_2O_5 in the second year did not affect seed yield. Plots given 200 kg/ha N yielded 24% more seed than those given 75 kg/ha N. Harvesting on 20 August gave 8% more seed than on 28 August or 3 September. Germination percentage was significantly raised by early sowing (12%), late harvesting (10%) and the large amount of N (4%). Monogermity exceeded 90% and was not affected by treatments. Early compared with late sowing gave significantly more small seed (<2·5 mm diameter) and less large seed (>3·25 mm diameter).

Fertilisers. Eight combinations of N and P_2O_5 fertilisers were applied as top dressings in the autumn or the following spring to a polyploid multigerm seed crop grown under barley in deep fertile soil at Sutton St. James, Lincs. After removing the barley, all plots received 88 kg/ha N and 250 kg/ha K_2O. P_2O_5 at 188 kg/ha in the autumn increased seed yield by 8%. The yield of seed from plots given 188, 250 or 312 kg/ha N increased from 4774 kg/ha by 4 and 10%; 250 kg/ha N and 125 kg/ha P_2O_5 gave more seed than 250 kg/ha N but not more than from 312 kg/ha N. None of the fertiliser treatments affected seed germination or size distribution.

In the second year of a monogerm seed crop grown *in situ* at Long Buckby, Northants, N was given at 200 kg/ha early (10 March) or late (14 May) or as a split dressing (100 kg/ha on 10 March followed by a further 100 kg/ha on 14 May). The yield of seed from the late N was 9% greater than from early or the split application. However, 12·8 g/kg less of the desirable large monogerm seed (>4·00 mm diameter) was produced and the germination was 4·5% less with the late or split dressing.

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Harvest date and method. Harvesting on 18 or 28 August gave similar yields from a crop grown from stecklings transplanted in March 1970 at Broom's Barn. Barn drying of plants cut and placed into bags gave 13% more seed than desiccation with diquat or swathing. Tripodding was not significantly different from any of the other treatments. Five per cent more of the seed harvested on 28 August germinated than of seed harvested on 18 August. Harvest methods did not affect germination. Monogermity was not affected by treatments. The early harvest gave a significantly greater proportion of small and light seed than the late harvest, but harvest methods had no effect.

Factors affecting seed performance. The following four experiments tested the performance of EMP steeped, dieldrin dressed seed from experiments harvested in 1969. The seed was sown at Broom's Barn in randomised block design experiments with six replicates on 21 or 22 April 1970.

Time of sowing and harvest. The seed was from crops sown on 5 July and 5 August 1968 and harvested on 21 August, 2 and 11 September 1969. Seedling emergence was not significantly affected by date of sowing or harvest of the seed crop. When harvested on 5 June 1970, shoot dry weight was not affected by date of harvest but was significantly (27%) larger from the early than from the late-sown seed crop.

Seed-crop fertilisers. Seeds from fertiliser plots harvested at Stonesfield, Oxon., on 3 September 1969 were sown in the field and on 8 June 1970 seedlings were counted; they were fewest from the largest amount of N with the least K_2O. P_2O_5 did not affect emergence and seedling shoot dry weight was unaffected by treatments.

Seed-crop plant population. Seeds from crops grown at six different plant densities and harvested on 3 September 1969 were sown in the field and all emerged equally and had similar shoot dry weights.

Pollinator, harvest date and method. Seeds from plots of male sterile plants fertilised either by diploid or tetraploid pollinators and harvested on 27 August and 5 September 1969 by each of four methods were sown in the field. Seedling emergence was significantly larger with diploid than with tetraploid pollinator, and from seed harvested late than early. Harvest methods did not affect emergence. Seedling shoot dry weight was 30% greater when the pollinator was tetraploid than when it was diploid and 11% greater from the late than from the early harvest; it was 12% smaller with seed harvested by the swathing treatment than by barn drying, desiccation to tripodding.

Grading. Using an air leg to separate four density grades, round hole sieves to separate four diameter grades and ribbed slotted cylinders to separate four thickness grades, a bulk of seed harvested in 1968 from a mixture of pollinator and male sterile plants was graded into 64 fractions. The weight and numbers of seeds in each fraction were recorded and the germination and monogermity measured. These results were used to calculate which fractions would produce a sample of given germination and monogermity, and how to remove the other fractions with fewest passages through machines.

A sample of seed was produced with more than 75% germination and 95% monogermity, but it amounted to only 57 g/kg of the starting material and to obtain these 2164 viable monogerm seeds, 37 388 viable monogerm seeds were lost in discarded fractions. Clearly the system is inefficient and must be improved. The recovery of this bulk of seed

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may have been unduly small because of the basically poor quality of seed harvested in 1968.

Seed advancement and washing. Cell counts on untreated seed and seed 'advanced' by 1, 2, 3, 4 or 5 cycles of imbibition and redrying showed that the relative numbers were 1·00, 1·44, 1·54, 1·70, 2·29, 2·19 ($\pm$0·003) respectively. This explains some of the effects of advancing.

Seed from eight samples that, after washing, gave 7·0 to 11·3% extra emergence from compost was washed and sown in the field. Seedling emergence was better from treated seed for seven of the eight samples by from 2·3 to 10·6%, a significant effect for one sample only and the mean. Seedling shoot dry weight was significantly increased for one sample only.

To test the effects of interactions of seed advancing, washing and the fungicide EMP or thiram, a 2^4 factorial experiment was made in compost in the glasshouse. Interactions were complicated but in general EMP steep gave fewer seedlings, advancing had little effect and thiram soak or washing alone or in combination with advancing gave up to 13% more seedlings and 30% greater shoot fresh weight. A negative interaction between thiram soaking and washing affected both seedling emergence and shoot fresh weight. Tests with different seed samples are in progress.

Storage. In July tubes of seeds at different moisture contents maintained at different temperatures since harvest in September 1968 were opened and seed sown in compost. The most seedlings emerged from the driest seed (8% m.c.) kept coldest (2°C). Seed stored at 18% moisture content at 10° or 22°C was dead. Seedling shoot weight was not significantly affected by seed moisture content or storage temperature.

Seed stored in tubes at different moisture contents and temperatures since harvest in September 1969 were then sown in compost. The driest seed (5% m.c.) kept at 10°C gave most seedlings. Seedling shoot weight was significantly greater the drier the seed.

Soil type. Seedling emergence was compared in microplots of four different soils brought to Broom's Barn; soil E—a black peat soil over fen clay from Ely; P—a loam over oolitic limestone from Peterborough; R—a flinty silt loam over clay with flints and chalk from Harpenden; T—a loamy sand with flints over glacial gravel from Thetford. Each plot was sown with 100 untreated seeds in one half and 100 'advanced' ones in the other half of var. Bush Mono. When sown (17 April), the soils had moisture contents of; E—69·5%, P—16·0%, R—22·2% and T—12·4%. The temperature at 2·5 cm depth rarely differed by more than 1° between soils, but the sand was 1·5°C warmer than the others at mid-day on clear sunny days. On 1 June the number of seedlings differed greatly in the different soils, ranging from 8% germination in R to 43% in T. Advancing the seed did not affect seedling numbers but produced heavier seedling shoots in both E and T soils. All soil types significantly affected seedling shoot weight which increased from P to R to T to E soils.

Soil condition. Eight soil conditioners applied to the heavy clay soils at Saxmundham had no effect on the emergence of seedlings. 'Advanced' seed gave larger but fewer seedlings than untreated soil, probably because it had been wetted and dried too much.

Soil type and moisture content. Raw and pelleted seed was sown 1 cm deep in sand, loam and peat soils equilibrated to different known moisture contents in plastic boxes, which were then sealed and incubated for 14 days at 15°C. The maximum emergence

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from sand was 80% at 9–15% moisture content, from loam 50% at 24–29% and from peat 70% at 18–23%, and emergence was much less on drier or wetter soils. Raw and pelleted seed behaved similarly, except in the driest sand, where the raw seed gave more seedlings.

Sowing depth and compaction. Loam and peat soil was equilibrated to 25 and 30% moisture content respectively and put into plastic boxes. One hundred pelleted seeds were placed in each box, covered with 1, 2 or 3 cm soil, and compacted by 0, 140 or 563 g/cm^2 pressure for 1 minute. Air-tight lids were placed on the boxes which were incubated at 15°C. Compaction did not affect emergence from seeds 1 cm deep. Emergence from seed at 2 and 3 cm in both soils was lessened by compaction at 563 g/cm^2, and from seed at 3 cm in the peat compacted at 140 g/cm^2. The average emergence percentages from 1, 2 and 3 cm depth were 88, 74 and 64. (Longden)

Sugar-beet manuring

The experiments dealing with peat remnant, magnesium and nitrogen were done in co-operation with the British Sugar Corporation in 1969.

NPKNa on peat remnant. It was the fourth and final year of experiments made on two Fenland fields in which the peat layer has become so thin that the plough penetrates the clay subsoil; N was applied at 0, 0·6 and 1·2 cwt/acre; P_2O_5 at 0, 0·75 and 1·5 cwt/acre; K_2O at 0, 1·0 and 2·0 cwt/acre and NaCl at 0 and 3·0 cwt/acre. Nitrogen was needed on both fields for maximum yield; one yielded most with 0·60 cwt/acre and the other with 1·2 cwt/acre. As in previous years, the field at Bardney needed phosphate, but this year 0·75 cwt/acre was enough; the crop at Peterborough did not respond to phosphate fertiliser. Neither sodium nor potassium was needed on either field. The results of all experiments made on these soils were published and are summarised on p. 000. Soils from 52 experiments on Fen soils were analysed for phosphorus, potassium, sodium, total nitrogen and loss on ignition, to seek relationship between these analyses and the response of sugar beet to fertilisers. The amount of phosphorus extracted from a given volume of soil with sodium bicarbonate predicted response and showed approximately how much fertiliser should be given. Potassium and sodium were usually plentiful and measurements of these were difficult to relate to crop responses. Loss on ignition was an acceptable guide to response to nitrogen fertiliser; when the loss was 14–25%, nitrogen increased yield by 6 cwt/acre sugar and 1·2 cwt/acre N was needed; when the loss was 26–35%, N increased sugar yield by 3·5 cwt/acre and 0·6 cwt/acre N was needed; with greater loss there was little response to N. (Draycott and Durrant)

Magnesium. Eight experiments compared kieserite and calcined magnesite as magnesium fertiliser and measured response to magnesium in sugar factory areas where such fertilisers had not been tested before. Fields were chosen where sugar-beet leaves were expected to show symptoms of Mg deficiency; all the soils were in the range 0–50 ppm exchangeable magnesium.

The treatments tested were 0, 1½ and 3 cwt/acre calcined magnesite (0, 90 and 180 lb/acre Mg); 2½ and 5 cwt/acre kieserite (45 and 90 lb/acre Mg). All plots received a basal dressing of 1·00 cwt/acre N, 0·50 cwt/acre P_2O_5, 1·00 cwt/acre K_2O and 3 cwt/acre salt. Responses to magnesium were small; it becomes increasingly difficult to find fields where the crop gives a large response, presumably because magnesium fertilisers have been used increasingly during recent years. On average, the two forms of magnesium gave similar

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increases in yield. Kieserite at 5 cwt/acre was marginally the best treatment, especially where leaf symptoms were most evident.

Nitrogen and soil type. The relationship between the amount of nitrogen fertiliser given and yield of sugar was further studied. Fields adequately manured with phosphate, potash and salt, were given eight equal increments of nitrogen ranging from 0 to 2·31 cwt/acre N as 'Nitro-chalk'. Four experiments were on soils with a sandy texture, three on shallow calcareous soils and three on deep, heavy clays.

On average of the four crops on sandy soils, increasing increments of nitrogen from 0–0·99 cwt/acre increased sugar yield greatly. Crops on the calcareous soils needed less nitrogen and the smallest dressing given (0·33 cwt/acre N) gave maximum sugar yield. Because nitrogen trebled yield in one soil, crops grown on the heavy soils needed most nitrogen, on average 1·32 cwt/acre. Giving more nitrogen than needed for maximum yield did not affect yield on any of the soils. (Draycott)

Plant nutrients

Sodium, magnesium and irrigation. The experiment described last year (p. 328) was repeated on Hackthorn field. Plants were taken from each plot at monthly intervals to measure their yield and leaf area, and for chemical analysis; also soil samples for chemical analysis. Due to the unusually dry weather from May to October a total of 6 in. of irrigation was needed to prevent the soil moisture deficit from exceeding 1·5 in.

Throughout the season the soil moisture deficit was greater in plots with salt than without, largely because the leaf area was increased early in the year. Both salt and irrigation increased leaf area, and yield of tops and roots at most harvests.

In August plants not irrigated and given salt showed signs of magnesium deficiency but magnesium fertiliser increased yield only slightly. At the final harvest irrigation decreased sugar percentage but increased sugar yield on average by 10 cwt/acre; salt increased it by 5 cwt/acre. (Draycott and Farley)

Nitrogen, cations and varieties. An experiment on Hackthorn field in co-operation with Dr. G. E. Russell of the Plant Breeding Institute, measured the response to nitrogen and cations by the sugar-beet varieties Sharpe's Klein E, Maris Vanguard, VT 137 and Anglo-Maribo Poly. A basal dressing of phosphate fertiliser was given and 0, 0·6 or 1·2 cwt N/acre as 'Nitro-chalk' applied in factorial combination with nil, 5 cwt/acre NaCl or 6·4 cwt/acre KCl. Seedling emergence of the four varieties on 20 May differed greatly; on average, Maris Vanguard produced 11 seedlings per yard and VT 137 only seven. On average of the varieties, sodium and potassium had no effect but nitrogen slightly decreased seedling emergence.

Nitrogen fertiliser greatly increased yield of all four varieties and more than usual was needed to give maximum yield. Indeed, the most given (1·20 cwt/acre) was not enough, probably because of the dry season. On average of the fertiliser treatments, Anglo-Maribo Poly yielded 70 cwt/acre sugar, Sharpe's Klein E 69 cwt, Maris Vanguard 64 cwt and VT 137 63 cwt. Sodium and potassium increased yield of all four varieties by similar amounts. Whereas 1·2 cwt/acre N increased yield of Sharpe's Klein E by 15 cwt/acre sugar, it increased yield of VT 137 by only 10 cwt/acre. (Draycott)

Nitrogen requirement. As in 1968 and 1969, nitrogen requirement of sugar beet was assessed on similar soils in the same factory areas. Top soil and subsoil in three fields were sampled on three occasions during the winter of 1969–70 and incubated aerobically

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or anaerobically. The calcareous loam contained most mineral N and released most when either fresh or air-dried soils were aerobically incubated. When incubated anaerobically, both the calcareous loam and the clay loam produced much NH_4-N whereas the sandy loam produced little. The calcareous loam subsoil contained most mineral N but the clay subsoil from the Nottingham factory area produced most when incubated.

Top soil and subsoil were sampled each month during the growing season from plots given 0, 0·99 and 1·98 cwt/acre N as 'Nitro-chalk' applied in the seedbed. Plants were analysed monthly for total N and for NO_3-N in mature leaves. Without N fertiliser, the root yields on the calcareous loam and sandy loam were only 8 and 10 ton/acre respectively, but 17 ton/acre from the clay loam. The large response (4·5 ton/acre) to 1·98 cwt/acre N on the sandy loam were predicted from the soil analyses, as were the smaller responses on the calcareous loam and clay loam. Analysis of the NO_3-N in petioles and leaf blades indicated that the petioles of plants on the sandy loam contained least NO_3-N and those from the clay loam most. Thus soil and plant analyses agreed well and were related to final yields. (Last)

Manganese. The experiments at Ely and Peterborough described last year (p. 329) were repeated but on different fields. The Ely soil, pH 7·8, contained 0·5 ppm water-soluble (W/S), 0·4 ppm exchangeable (Ex), 24·7 ppm easily-reducible (E/R) and 25·4 ppm available (Av) manganese. The Peterborough soil, pH 8·0, contained 0·1 ppm W/S, 0·8 ppm Ex, 17·3 ppm E/R and 7·0 ppm Av manganese. Similar Mn treatments to last year were tested but the manganese oxide dressing was increased to 16 lb/acre Mn. At Ely 20% of the untreated plants had deficiency symptoms in June, and at Peterborough 40%. All treatments lessened the number of plants with symptoms on both sites, but only the sprays completely cured all symptoms. The sprayed crop also grew more vigorously. However, by August all plots looked alike and none had plants showing symptoms. None of the treatments affected yield.

At West Row Fen, near Ely, on two fields where the plants showed severe Mn deficiency, the crops were sprayed with $MnSO_4$ during May and June. Field (I) soil was pH 7·6 and contained 0·8 ppm W/S, 0·3 ppm Ex, 40·6 ppm E/R and 8·5 ppm Av Mn. Field (II) soil was pH 6·5, and contained 0·5 ppm W/S, 1·5 ppm Ex., 38·9 ppm E/R and 5·1 ppm Av Mn. On field I, 8 lb/acre Mn alleviated the disease and 16 and 24 lb/acre cured it. All treatments increased the sugar yield, 8 lb/acre by 2 cwt, 16 lb/acre by 3 cwt and 24 lb/acre by 7 cwt/acre. On field II, the treatments alleviated the disease but did not affect yield.

Similar Mn treatments were tested in pots of soil from the two fields with and without lime. Liming decreased the E/R Mn concentration of the Peterborough soil but not of the Ely soil. The plants in limed soil contained less Mn and showed most severe symptoms. Both kinds of Mn applied to the soil increased the E/R Mn concentration of the soil and they and the spray increased the Mn concentration in plants in the order spray > manganese oxide > fritted trace elements. The spray and the oxide completely eliminated symptoms but the frit only alleviated them. None of the treatments affected the dry matter of the plants. (Draycott and Farley)

Soil compaction

An experiment similar to that described last year (p. 330) was made on White Patch field, but with an additional treatment to test the effects of phosphate fertiliser. In contrast to 1969, compaction significantly decreased the seedling population; it also slightly, but not significantly, decreased the final plant population. It greatly decreased the yield of

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sugar; winter compaction by 1 t/ha (8 cwt/acre), and spring compaction by 0·3 t/ha (2·6 cwt/acre). Both root yield and sugar percentage were decreased. Soil bulk density on the uncompacted plots was 1·65 g/ml, on the winter-compacted 1·80 g/ml, and on the spring-compacted 1·61 g/ml. There was no interaction between nitrogen fertiliser and compaction on yield. The optimum amount of N was 75 kg/ha (0·6 cwt/acre) and the effects of nitrogen and of phosphate were not significant. Early in the season, the roots seemed more fangy on the compacted plots, but not at the final harvest. (Jaggard)

Plant spacing

Fertiliser, spacing and irrigation. This new experiment examined how density of plant stand, fertiliser and irrigation affect yield and moisture use of sugar beet. The plant populations (S_1—7·5, S_2—15, S_3—30 and S_4—55 thousand/acre) were in a factorial design with 0 and 1·5 cwt/acre K_2O and 0 and 5·0 cwt/acre NaCl. Sub-blocks were irrigated to prevent the soil moisture deficit from exceeding 1·5 in.; half the plots were given 1·0 cwt/acre P_2O_5.

The soil moisture deficit increased from May until October. The crop was irrigated twice in June—the first time we have irrigated sugar beet so early in the year—and in July, August and September, bringing the total to 6 in. The average response to the water was 11 cwt/acre sugar.

The moisture in the soil to a depth of 6 ft was measured every week by a neutron moderation meter. The amount of water used by the crop increased with increasing plant density, and the largest population used about 1·5 in. more than the smallest. Irrigation increased the amount of water used. The mean sugar yields from the four populations were S_1—52·7, S_2—73·4, S_3—75·8 and S_4—75·8 cwt/acre. Phosphate had no effect on sugar yield but potash and salt together increased it by 5·2 cwt/acre. (Draycott and Messem)

Plant density and distribution. The effects of four plant distributions along the row at four plant densities ranging from 21 000 to 39 000 plants/acre (51 900 to 96 400 plants/ha) were examined on Hackthorn field in a factorial, randomised block experiment of three replicates. The four plant distributions were: drilled to a stand; plants spaced regularly along the row; plants spaced in pairs separated by half the mean spacing; and plants spaced in triplets with each plant separated from its nearest neighbour by half the mean spacing. Pelleted monogerm var. Amono was sown at 2 in. spacing and the different plant distributions obtained by hand singling. Irregular emergence gave slightly smaller populations on the hand slingled plots than intended. Root and sugar yields decreased by approximately 1 ton/acre (2·5 t/ha) and 5 cwt/acre (0·625 t/ha) respectively as the degree of irregularity increased. Sugar percentage also decreased slightly. Plant population had little effect on root or sugar yield at regular spacings, but irregular distributions of populations fewer than 30 000 plants/acre (74 000 plants/ha) decreased sugar yield by 4·5 cwt/acre (0·6 t/ha). When drilled to a stand, differences in plant density did not affect yield which was similar to that from the regularly spaced crop. (Jaggard)

Root studies

How sugar-beet roots were distributed was again studied in co-operation with Drs. P. Newbould and F. B. Ellis of the Agricultural Research Council's Letcombe Laboratory, on crop densities of 7500 and 55 000 plants/acre, with and without irrigation. One of the two radio-active tracer methods used was placing a solution containing ^{32}P in the soil

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at 6, 12, 18, 24 and 36 in. deep as last year (p. 331). The other, not previously used on sugar beet, was to inject a solution of ^{86}Rb into the plants. The radio-activity of plant and soil samples is being measured at the Letcombe Laboratory.

Root growth of sugar beet, potatoes and barley was again studied in the observation pits. Prolonged dry periods hindered establishment of the sugar beet and potatoes. A few roots of all crops eventually penetrated below 4 ft but roots ramified the soil less thoroughly and deeply than in 1969. Maximum soil moisture deficits (measured with a neutron moderation meter between soil surface and 4 ft deep) were: sugar beet 5·2 in.; potatoes 4·1 in. and barley 5·0 in. (Draycott and Durrant)

Time of sowing, harvesting and nitrogen need

An experiment on dates of sowing and harvesting gave yields shown in Table 4. Yields were large, 79 cwt/acre of sugar from the April sowing harvested in December; the root yields from 0, 0·6, 1·2 and 1·8 cwt/acre of nitrogen averaged 16·3, 18·9, 19·1 and 19·5 ton/acre at 18·5, 18·5, 18·2 and 17·8% sugar respectively, giving sugar yields of 60·4, 69·5, 69·4 and 69·2 cwt/acre. Nitrogen at 0·6 cwt/acre was enough for maximum sugar yield, irrespective of sowing and harvesting date. Plots sown in March yielded slightly less than those sown in April, and delaying sowing until May decreased yield greatly. Delaying lifting during October increased yield on all plots with nitrogen fertiliser, with a further slight increase from delaying lifting of the later sown plots during November.

TABLE 4

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	cpa	%	cpa	%	cpa	%	cpa	%
26 March	60·4	18·6	74·2	19·1	73·6	17·3	69·4	18·4
24 April	63·6	18·6	74·2	19·2	78·7	17·4	72·2	18·4
12 May	52·0	18·1	63·5	18·7	64·3	17·1	59·9	18·0
Mean	58·7	18·5	70·7	19·0	72·2	17·3	67·2	18·2

The concentration of nitrate in the petioles was assessed from mid-June, when the late-sown crop was just large enough to sample, until December. Petiole nitrate concentration in June fluctuated between 250 and 100 ppm fresh weight. By late June, petioles from the earlier-sown plots without nitrogen fertiliser contained only 100 ppm nitrate. The concentration in petioles from the last-sown plots decreased to 100 ppm by late July. Petioles from plots with 0·6 cwt/acre nitrogen averaged 500 ppm nitrate in mid-July and less than 100 ppm from mid-August onwards. Plots with 120 and 180 units N contained 700 and 900 ppm NO_3 in mid-July and 150 and 300 ppm in mid-August. For maximum sugar yield, the concentration of nitrate needed in mid-July was March sowing—450 ppm, April sowing—650 ppm and May sowing—800 ppm. In mid-August, optimum NO_3 concentration was less than 100 ppm for all sowing dates.

Plants from the three times of sowing, given 0, 1·2 and 1·8 cwt N/acre were sampled and analysed for growth seven times between 18 May and 7 September. Until the end of June, plants from the first time of sowing had the largest leaf area index (LAI) and had accumulated most dry matter. After the end of June, however, the first and second times of sowing had much the same LAI with a mean of 1·1 on 29 June, a value reached by the latest sown plants in mid-August. Throughout the season, plants given 1·2 and 1·8 cwt/

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acre N from all times of sowing had similar LAI and dry matter accumulation. It was not until mid-July that the increase in LAI and dry weight of plants not given nitrogen slowed to less than the other nitrogen treatments. (Jaggard and Wright)

Growth control chemicals

The growth control chemical 'PRB-8' was sprayed on Sharpe's Klein E sugar beet on 12 May, 9 June or 6 July at 0·375, 0·75 or 1·5 kg a.i./ha (in co-operation with Shell's Woodstock Research Centre). The mean yield from the experiment was 7·64 t/ha of sugar. The sprays in May decreased yield and the small amounts of chemical applied in June and July increased yield slightly but no effect was significant. The chemical had no consistent or significant effect on sugar percentage.

The growth control chemical 'Mon. 0845', from Monsanto Chemical Corporation, sprayed on sugar beet var. Amono on 14 September, 35 days before harvesting at 0·85 and 1·70 kg/ha, had no significant effect on yield of roots, sugar (6·97 t/ha) or tops. At 3·3 kg/ha it severely damaged the foliage of all varieties tested. On average it decreased yield of roots, sugar and juice purity, but increased sugar percentage by 0·6%. Different varieties behaved differently and the spray increased yield of Monotri, Monitor, and Monobeet, though not significantly. (Jaggard and Webb)

Herbicides and weed control

Chenopodium album grew unusually strongly in parts of the beet crop where weed control was delayed and greatly decreased yields. In experiments at Broom's Barn, by Mr. W. E. Bray of Norfolk Agricultural Station, plots with various pre-emergence and post-emergence herbicides which controlled weeds yielded around 60 cwt/acre of sugar, whereas unweeded plots yielded only 41 cwt/acre.

Hormone weedkillers. To estimate the effect of small doses of herbicides, such as may drift to beet crops when cereals are sprayed or come from contaminated sprayers, sugar beet was sprayed once on different occasions at weekly intervals with MCPA or 2-4D, at 1/20 the concentration recommended for cereals, between 1 June and 6 July, 11 weeks after sowing. Plants were severely distorted by sprays of both materials on the first three occasions but much less on the last three. The average yield loss from the three sprays between 1 June and 15 June was 13% with MCPA and 17% with 2-4D, and for the three sprays between 22 June and 6 July, 4% and 6% respectively for the two herbicides. (Byford)

Stubble cultivations. An experiment was started in 1967 on White Patch field to examine the effects of herbicides applied to the cereals and stubble treatments on the weed populations in sugar beet. Half of the plots of Cappelle winter wheat sown in October 1967 and of Sultan spring barley sown in March 1969 were sprayed with herbicides that kill broad-leaved weeds. The sprayed and unsprayed plots were in factorial combination with the following six stubble treatments before ploughing: (1) not cultivated; (2) cultivated twice; (3) stubble and straw burnt; (4) burnt and sprayed with paraquat; (5) not cultivated but sprayed with paraquat; (6) cultivated and sown with fodder raddish. The herbicide had no significant effect on either grain or straw yield of the cereals, but significantly decreased the proportion of the ground covered by weeds before ploughing in December, from 16·3% to 9·9% (±1·54) in 1968 and from 12·2% to 2·5% (±1·62) in 1969. Except in 1968, when neither burning the stubble nor cultivation and growing a

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green cover crop controlled weeds, weed cover was always greater with treatment (1), no cultivation.

In 1970 the experiment was drilled to a stand with sugar beet var. Bush Mono at 12·7 cm (5 in.) spacing, and the plots were split and either the pre-emergence herbicide 'Pyramin', or the post-emergence herbicide 'Betanal', were applied. Weeds were counted before and after applying 'Betanal'. Without 'Pyramin' or 'Betanal' the treatments of the two previous seasons had no significant effect on weed numbers. By 10 June weeds were fewer with 'Pyramin' than with 'Betanal', because 'Pyramin' was more effective against the dominant weed species which were *Melandrium album* Mill., *Veronica persica* Poir., *Stellaria media* (L) Vill., *Atriplex patula* L., *Polygonum convolvulus* L., and *Polygonum aviculare* L. The same species, except for *Polygonum aviculare* L., were dominant after spraying, although fewer.

No treatment significantly affected sugar yield, root yield or plant population. Where the stubble had been burnt but not sprayed with paraquat, sugar percentage was significantly less than the mean but the reason is not known. The treatments over two years seem not to have affected appreciably the number of weed seeds in the soil. (Jaggard)

Varieties

Five monogerm and three multigerm commercial varieties were sown at 5 in. spacing on 1 May on Hackthorn Field. Harvested plant populations averaged 27·6 thousand/acre and Hilleshog Monotri gave the fewest (24·3). The sugar yield of the five monogerm varieties range from 77% to 100% of the average of the three multigerm varieties, which yielded 65·7 to 66·3 cwt/acre of sugar. Bush Mono yielded approximately the same as the multigerm varieties. (Webb)

Plot size and shape

Uniformity trials determined the effects of different plot sizes and shapes on the experimental error for sugar-beet crops on Marl Pit and Little Lane fields in 1969. Both crops were drilled to a stand at 12·5 cm (5 in.) spacing. An area of 24·5 × 25·4 m (80 ft × 50 × 20 in. rows) was harvested by hand in units of one row × 4·9 m (16 ft). A range of plot sizes and shapes was then built up from these units, and the yields and coefficients of variation were calculated.

The coefficient of variation for root yield showed no advantage from harvest areas greater than 15 m^2 (18 yd^2), and harvest areas smaller than 10 m^2 (12 yd^2) gave greater error values. Harvest areas of approximately 15 m^2 (18 yd^2) were accurate and economical, giving coefficients of variation of 3–4%. Results for plant population showed the same trend, but the errors were greater. Variations in plant population might account for some of the root yield variance, so this was investigated in 1970, but results are not yet known.

When plots of different shapes but of the same harvest areas were compared, single rows gave greater coefficients of variation than harvesting the three centre rows of a five-row plot, but the latter gave approximately the same coefficients of variation as harvesting the centre six or eight rows of a ten-row plot. (Jaggard)

Cereal and rotation experiments

Fertilisers on rotation crops. This was the sixth year of the long-term experiment that tests fertilisers applied during a rotation of sugar beet, winter wheat and barley, and two rotations have now been completed. (For the fertiliser dressings, see *Rothamsted Report for 1965*, 279, Table 7). Wheat and barley yields were poor because of the dry summer,

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but sugar beet yielded well on fertilised plots. Table 5 shows that, even after five years of exhaustive cropping, fertilisers increased wheat yields little. Barley was much more responsive and a moderate dressing of NPK (Compound 1) increased grain yield by 8 cwt/acre; a large dressing (Compound 2) increased it by a further 3 cwt/acre. Sugar beet was also very responsive to all the nutrients tested and there are now signs that phosphate is needed for maximum yield. More fertiliser was needed and sugar-yield responses were greater in 1970 than ever before. (Draycott and Durrant)

TABLE 5

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

	Wheat grain (cwt/acre at 85% DM)	Barley grain (cwt/acre at 85% DM)	Sugar Beet sugar (cwt/acre)
Mean yield	23·5	20·6	48·3
Response to:			
N_1	+2·2	+4·6	+2·7
N_2–N_1	−2·9	+2·8	+3·0
P_1	−0·9	+2·5	+3·3
P_2–P_1	+0·4	+2·4	+1·0
K_1	−0·8	+2·2	+5·1
K_2–K_1	−4·1	+0·7	+8·1
Na	−0·3	+1·1	+6·7
FYM	+0·5	+0·4	+10·6
Compound 1	+3·1	+8·4	+13·7
Compound 2–Compound 1	−2·7	+3·0	+2·0

Frequency of beet and barley. This year the different crop rotations had only small influence on yield of beet and barley in this phased rotation experiment (*Rothamsted Report for 1969*, Part 1, 334). Beet grown on the same plots for six consecutive years yielded 53·2 cwt/acre of sugar, compared with 55·6 cwt/acre in arable crop rotations and 59·3 cwt/acre after a two-year grass ley. Continuous beet and beet in arable rotations yielded most sugar with 100 units N/acre, after grass, with 50 units N/acre. Yields of potatoes (8 tons/acre), beans (12 cwt/acre of grain), barley (16·5 cwt/acre grain) and grass were small because these crops suffered from drought. First and second barley crops yielded about 17 cwt/acre and the fourth and fifth, 15 cwt/acre. None of the rotation crops showed any residual effect from N applied to the sugar beet. (Hull)

Nitrogen and fumigation. A new long-term experiment was started on Brome Pin field to investigate the residual effects of soil fumigation on yields of sugar beet, wheat and barley, plant pathogens and available soil nitrogen. Plots were fumigated by hand injectors with 33·3 gal/acre Shell 'D-D' on 18 March. Ammonium and nitrate forms of nitrogen were tested at 1·00 cwt/acre N. This year the experiment was cropped with sugar beet.

Fumigation had little effect on nematode populations or on available soil nitrogen, probably because very wet soil at the time of injection prevented thorough dispersal of the fumigant. The commonest plant-parasitic nematodes were *Tylenchorhynchus* (388/litre soil unfumigated plots, 232/litre fumigated plots), *Pratylenchus* (675/litre unfumigated, 569/litre fumigated) and *Paratylenchus* (588/litre unfumigated, 1069/litre fumigated). Plots without nitrogen fertiliser contained 37 lb/acre available N in the surface soil (0–9 in.) and 45 lb/acre in the subsoil (9–24 in.) on 19 May. When given 1·00 cwt/acre N in either form, the plots contained 110 lb/acre in the surface soil and 80 lb/acre in the subsoil.

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Fumigation increased yield by only 0·5 cwt/acre sugar on average. The two forms of nitrogen had similar effects on yield; ammonium increased sugar by 8·5 cwt/acre and nitrate by 7·4 cwt/acre. There was little evidence of any interaction between fumigation and response to the different forms of nitrogen. (Cooke and Draycott)

Magnesium and boron. A new experiment began on Brome Pin field to investigate the long-term effects on crops and soil of magnesium and boron given for sugar beet. The treatments were 5 cwt/acre keiserite, 7·5 cwt/acre magnesium limestone, 1·5 cwt/acre calcined magnesite and 20 lb/acre borax. A suitable dressing of major nutrients was given to all plots and sugar beet was grown. The average sugar yield was 63 cwt/acre but neither the magnesium fertilisers nor the borax affected the yield. (Draycott and Farley)

Fungicide on barley. Ethirimol applied as a seed dressing again controlled powdery mildew of barley well. Brown rust also occurred in the experiment but was less serious than mildew and was only slightly affected by the fungicide. Yields of grain (Table 6) were small because of drought and grain loss during a week of weather unsuitable for harvesting when the crop was ripe. The fungicide increased yield of both Sultan and Zephyr, which were equally susceptible to mildew; it also increased the 1000 grain weight. Neither variety responded to extra N this year.

TABLE 6

Effect of ethirimol seed dressing on the yield of barley

(Cwt/acre grain at 85% dry matter)

Seed dressing	Sultan N1	Sultan N2	Zephyr N1	Zephyr N2		Mean	
Nil	15·2	15·6	15·9	17·4	±0·93	16·0	±0·66
12 oz/cwt	20·7	17·2	22·8	20·3		20·3	
32 oz/cwt	19·1	17·7	19·5	19·1		18·8	
Mean ±0·54	17·6		19·2				

An adjacent trial tested the effect of tridemorph ('Calixin') sprayed on 1 June on to four spring barley varieties given 70 or 110 units N/acre. The fungicide spray increased yield on average by just over 1 cwt/acre of grain (mean yield, 1 ton/acre) and also increased to 1000 grain weight of all varieties. The extra N had little effect on yield on average but the fungicide increased yield more without than with the extra N. (Webb)

Broom's Barn farm

Ploughing was completed by 15 January, but rain prevented further work on the land until mid-March. Flint Ridge and Marl Pit fields were both deep cultivated and levelled.

TABLE 7

1970 cereal and bean yields at 15% moisture content

	Acres		Cwt/acre
Brome Pin	20·0	Sultan barley (undersown)	18½
Marl Pit	12·7	Sultan barley	21
New Piece	0·9	Sultan barley	24½
	12·0	Joss Cambier wheat	31½
Dunholme	22·1	Cappelle wheat	21½
Windbreak	4·0	Cappelle wheat	33½
Bullrush	11·4	Maris Ranger wheat	36½
Little Lane	21·6	Kolibri wheat	27
The Holt	11·0	Maris Bead beans	16

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Five acres of sugar beet were irrigated in late May to assist seedling establishment. The ley and the main beet crop including most experiments, were watered during the summer, some beet twice. A small area in the south-east corner of Flint Ridge was limed and cultivated before farmyard manure was spread over the field and ploughed in. Marl Pit was also given farmyard manure. Cereals were manured and sprayed with herbicides as in previous years. None lodged and yields were as in Table 7.

Beans. Maris Bead tick beans were drilled with 2 cwt of a 0 : 20 : 20 compound in late March and sprayed with 1½ lb/acre of 'Gesatop' on 24 April. Some weeds grew but the herbicide did not damage the beans. Aphid control was unnecessary.

Fodder crops. The Italian ryegrass and clover mixture on Flint Ridge was made into silage in early June. The field was immediately top dressed with 40 units N/acre and given 2 in. of irrigation to yield a light hay crop in mid-July.

The new ley under the barley on Brome Pin was threatened by drought but eventually established well.

Sugar beet. The basic fertiliser on White Patch and Hackthorn fields was 6 cwt/acre kainit applied in the autumn and 5¾ cwt/acre of 20–10–10 compound on the seedbed. Sowing started on 26 March but did not finish until 12 May. All the crop was sown with graded seed, 22 acres with monogerm seed at 5 in. spacing. Most of the crop was band sprayed with 'Pyramin' at drilling and the rest sprayed with 'Betanal' after emergence. Five acres of commercial beet did not need tractor hoeing. Insecticide was sprayed only where viruliferous aphids had been put out. Lifting started on 2 October when the soil was very hard, and ended on 17 December when the ground was very wet. Deliveries to the factory from the clamp continued until early January. Yields averaged 15 ton/acre of clean roots, at an average sugar content of 17·5%, ranging from 15·4 to 19·6%. Mean dirt and top tares were 14 and 4·4 lb/cwt. The country's average yield this year was 14·3 tons/acre of roots at 17·03% sugar.

Livestock. During early October 1969, 35 Hereford-cross steers at an average live weight of 600 lb and 41 Hereford-cross heifers, at an average live weight of 554 lb were bought for fattening. All were fed silage *ad lib*, hay and a 75% barley : 25% sugar beet pulp concentrate up to a maximum of 10 lb/head/day for the steers and 7 lb for the heifers. At first a protein supplement was added to the concentrate ration. The average live weight gain was 1·5 lb/head/day for the steers and 1·3 for the heifers to give an average live weight of 938 lb and 818 lb respectively when sold between 7 April and 2 June. Seventy-five steers were bought in early October 1970. (Golding)

Staff and visiting workers

Dr. F. J. Hills on sabbatical leave from University of California, Davis, spent four months at Broom's Barn and Mr. Th. Strouthopoulos and Mr. C. Dovas, Plant Pathologists of the Hellenic Sugar Company, spent a month learning techniques with viruses and aphids. A Sandwich Course student, A. Moore (University of Bath) was with us for six months.

R. Hull became chairman of the Scientific Advisory Committee of the International Institute of Sugar Beet Research and of the Editorial Board of the I.I.R.B. Journal. In February, with R. A. Dunning and A. P. Draycott, he attended the Winter Congress in Brussels. In May a Symposium on sugar beet seedling pests and diseases, organised

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under the auspices of the I.I.R.B. at Broom's Barn, was attended by representatives of most West European countries and the United States. In October A. P. Draycott attended a meeting at Göttingen, Germany, to discuss field-experiment procedure with sugar beet. In June, a Symposium at Broom's Barn on sugar-beet plant density was chaired by Professor C. P. Whittingham of Imperial College, and was attended by research workers from Sweden, Holland and England. Lectures and symposia during the winter months were well attended. A two-day training course for sugar factory fieldmen was held in July. Groups of visitors included members of the Agricultural Development and Advisory Service in the West Midlands, the British Society of Soil Science, and the University of Leeds.

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