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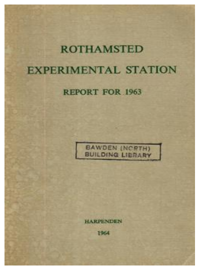

Broom's Barn Experimental Station

R. Hull

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BROOM'S BARN EXPERIMENTAL STATION

R. HULL

M. Church was appointed Farm Bailiff to succeed C. J. Hingston. M. Glenister left at the end of the year. R. Hull and R. A. Dunning attended the winter congress of the International Institute of Sugar Beet Research in Brussels and R. Hull the summer meeting in Spain.

The pattern of work has changed from that at Dunholme. Laboratory and glasshouse work has increased considerably, the subjects of field experiments are more diverse and visitors are more numerous, with 300 coming on two consecutive visitors' days in July. Lord St. Oswald, Parliamentary Secretary, Ministry of Agriculture, visited us with the Suffolk Agricultural Executive Committee. The agricultural staffs of 10 of the British Sugar Corporation's factories each spent a day with us, and 37 fieldmen attended a two-day course of instruction on survey and experimental work. These visits led to many requests for advice on beet growing and identification of samples of pests and diseases. The staffs of the sugar factories again gave invaluable help with the outside field experiments and surveys.

A colloquium on sugar-beet virus diseases at Broom's Barn, under the auspices of the International Institute of Sugar Beet Research, was attended by 26 delegates from west-European countries and the U.S.A. Scientific meetings held each month during the winter were well attended by research workers, officers of the National Agricultural Advisory Service, sugar factory agricultural staffs and other agriculturists. The main hall was in regular use for these and for other meetings.

The severe winter hindered preparations for sowing grass and planting shrubs and trees round the buildings, but this work progressed in the late spring and during the autumn.

Yellows and aphids on sugar beet. Snow and severe frosts persisting into March, and cold, wet weather in April meant a late start, and most crops of sugar beet were sown in late April. A more fortunate consequence of the harsh weather was that aphids infested sugar beet late. Few green aphids occurred on sugar beet during May and June, but at the end of June *Aphis fabae* began to increase on them. Infestations were large in July, and growers sprayed 241,000 acres of sugar beet with systemic insecticides to prevent the threatened damage. These sprays also controlled green aphids, which remained few and the average infestation reached 1 per 6 plants by the middle of July, an infestation reached at the end of May or early June in years when yellows is severe. The infestation was short-lived and remained small throughout August and September. Sticky-trap catches of winged aphids paralleled the observation on plants. *Myzus persicae* was not trapped until July, but in total twice as many aphids were trapped as in 1962, largely because of the many *A. fabae*, which comprised

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about a quarter of the total catch. Yellows was nowhere severe, and incidence averaged 0·24, 1·5 and 2·9% at the end of July, August and September respectively on sample fields throughout the country, the smallest so far recorded. Sugar-beet crops grew rapidly in June and, in spite of the late start, many had covered the ground by the end of the month. The country's average yield of sugar was 42·9 cwt/acre from 12·9 tons/acre of roots at the large average sugar content of 16·7%.

Timing of insecticide sprays. Few spray warnings were called for, so many of the experiments planned to test their timing were abandoned, but 17 were made comparing one, two or three sprays in areas where yellows has usually been prevalent. In most of these fields yellows was rare, even on the unsprayed plots. Only in the trial near Cambridge did the disease spread appreciably during August and September; on average, the unsprayed plots had 9·8% infected plants at the end of September, and those sprayed once and twice had 8·6 and 8·4%. The sprays did not prevent this spread of yellows, which was too late to affect yield appreciably. (Heathcote)

Sources of aphids and viruses. The sugar factory fieldmen sent in 143 samples of overwintered weeds collected from sheltered sites adjacent to mangold clamps, beet seed crops or fields where sugar beet was grown in 1963. Only 12% of samples were infested with aphids, and only one with *M. persicae*. Two samples of chickweed (*Stellaria media*) infected with beet mild yellowing virus (BMYV) were the only ones from which beet viruses were isolated either by mechanical transmission or by aphid transmission to test plants. In contrast to this rarity of transmission from weeds aphids from 5 of 12 infested samples of shoots from clamped mangolds transmitted beet yellows virus (BYV) to beet seedlings. (Heathcote and Dunning)

Unlike 1962, beet aphids were not found on wild beet (*Beta maritima*) on the east coast, where half of the plants were killed or their foliage destroyed by the hard frost. Similarly, aphids were not found on beets unharvested the previous year. The hard winter killed most of these plants, and ground-keepers were probably fewer than after a normal harvest and winter.

Eggs of *M. persicae* on peach and of *A. fabae* on spindle were unharmed by the severe winter, and hatched from about the first week in April.

Work with A. J. Cockbain on the transmission of viruses in relation to the behaviour and physiology of aphids is described in the Entomology Department report. (Heathcote)

Aphid parasites. This year, the earliest record of an *Entomophthora* sp. attacking aphids in the field was on *A. fabae* near Lincoln on 17 July (probably *thaxteriana*, Petch). Thereafter *Entomophthora* spp. were frequent on the abundant *A. fabae*, and on other aphids, such as *Cavariella pastinacea* L., and *Metopolophium dirhodum* Walk., which were common. The four species of *Entomophthora* that were recorded in 1962—*E.*

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planchoniana Corn., *E. aphidis* Hoff., *E. fresenii* Nowakowski and E. sp. (probably *thaxteriana*) were all found. In 16 fields in Norfolk and Suffolk surveyed on 23 August *E. fresenii* was the dominant species, whereas *E. aphidis* was the most prevalent in this area in 1962. (Byford)

Mangold clamps. As in 1961 and 1962, fieldmen surveyed mangold clamps during late April. Of 2,557 farms in beet-growing areas, half grew mangolds, fodder beet or red beet, and 461 still had clamped mangolds at the time of the survey; aphids infested only 18 of these. Despite the very severe winter, the number of clamps remaining in April was about the same as in 1962, but far fewer were aphid-infested. For the three years of the survey the intensity of aphid-infested clamps in late April roughly parallels the incidence of yellows at the end of August in beet fields in the areas surveyed, viz.: 1961, 0·52 aphid-infested clamps per square mile—21·2% yellows; 1962, 0·11–1·9%; 1963, 0·02–1·5%.

Because aphid-infested clamps were so few, a project to fumigate all clamps in an area between Cambridge and Bury St. Edmunds was abandoned.

Preliminary experiments tested the phytotoxicity of two formulations of dichlorvos to small batches of mangolds in small clamps. Dichlorvos incorporated in resinous pellets sprinkled among the mangolds at different dosage rates did not affect the mangolds, but a liquid formulation, absorbed on paper strips placed among the mangolds, seriously damaged the mangolds where it touched them. (Dunning)

Seed crops. Samples of stecklings from 78 beds inspected in October 1962, grown-on in small plots at Broom's Barn, averaged 3·7% plants with virus yellows in June and 0·8% with downy mildew. As in previous years, both yellows and downy mildew were most prevalent in plants raised under mustard cover crops. Eleven such steckling beds gave 9% of seed plants with yellows and 4·1% with downy mildew, compared with 2·4% yellows and 0·3% downy mildew in crops planted from 44 steckling beds with cereal cover crops. The use of mustard as a cover crop is being given up, and only one crop was grown in this way in 1963. Very few (probably only five) mangold seed crops survived the severe winter, and so the potential threat from the greater than usual incidence of yellows in them in the autumn of 1962 did not materialise. (Byford)

With the co-operation of six major seed-producing firms, the infestation of beet-seed crops by green and black aphids was surveyed so that spray warnings for seed crops could be given. From the last week of May to mid-July samples consisting of a few inches from the top of the leading shoot and one mature leaf from over 3,700 plants were examined; they came from 42% of all beet-seed fields. Only five wingless *M. persicae* were found and no winged ones. Black aphids lightly infested 57% of the crops examined during the first week; they multiplied steadily, and in the third week of June seed firms were advised to spray seed crops with insecticide to prevent damage. (Heathcote)

In 1963 most summer-sown stecklings emerged after aphid populations had reached their peak in late July. Nearly all the seed used to sow steck-

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lings in the summer was treated with the systemic insecticide menazon and this doubtless resulted in steckling beds being unusually free from yellows. The average incidence of 0·1% yellows in beet and 0·05% in mangold stecklings are the smallest recorded. Of 174 beet steckling beds, 4 had more than 1% yellows, and these were open beds inadequately isolated, and drilled early; 1 had more than 3% downy mildew. Of 188 mangold and red-beet steckling beds, only 1 had more than 1% virus yellows, and 1 other was rejected as it had 20% downy mildew. (Byford)

Insecticides on stecklings. Insecticides greatly decreased the incidence of yellows in the seed crops grown from the steckling experiments described in the Rothamsted Report for 1962, pp. 219–220. At Melton Mowbray most of the larger stecklings were killed by frost during the winter, but the losses were fewer at the other two sites. Stecklings were transplanted at Broom's Barn at the end of March from the trials at Broom's Barn and Melton Mowbray; the plants at Sleaford were grown on *in situ*. Insecticide was not applied in 1963.

In June an average of 56% of plants in the untreated plots in the three trials had yellows; the seven insecticide treatments decreased yellows incidence by the following amounts (for rates of application see Report for 1962); one disulfoton top dressing on foliage—45%; three foliage sprays of demeton-methyl—50%; menazon seed treatment—58%; two disulfoton top dressings on foliage—59%; menazon granules with seed—66%; menazon seed treatment + disulfoton top dressing on foliage—74%; menazon granules with seed + disulfoton top dressing on foliage—76%.

These results follow the pattern expected from the type, dosage rate and timing of the insecticide application. Insecticides applied at drilling decreased yellows more than those applied after emergence, because there was a large early aphid infestation; the effect of menazon seed dressing, and of menazon granules sown with the seed, was improved by top dressing with disulfoton granules in early September.

Both sugar-beet and mangold seed growers have been quick to adopt menazon seed treatment to protect stecklings from aphid infestation during the first few weeks after emergence. Half of the 124 sugar-beet beds sown under cereal cover crops in April were so treated, probably unnecessarily as it happened in 1963, and 81% of the 43 summer-sown beds. Similarly, three-quarters of the 215 mangold steckling beds were sown with menazon-treated seed. (Dunning and Winder)

Insecticides on the root crop. The experiments described below tested menazon as a seed treatment and different methods of applying granular formulations of menazon and disulfoton for any phytotoxic effects and further control of aphids and yellows.

Menazon seed treatment at 5% by weight of product containing 80% active ingredient (a.i.) and 5% granules combine-drilled in the furrow with the seed at 10, 20 and 28 oz a.i./acre (20-in. rows) were tested with Sharpe's E seed, rubbed and graded to $\frac{7}{64}$–$\frac{11}{64}$, dieldrin-treated, with or without EMP steep. Eight replications of 45-ft row plots were drilled at Broom's Barn on 8 April. Using seed without EMP steep, all menazon treatments

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increased seedling and final plant populations; the greatest increase was by seed treatment, 19% and 5% respectively. With EMP-steeped seed, menazon seed treatment did not affect seedling populations; greater amounts of menazon granules depressed seedling population slightly, but not the final plant population. No significant phytotoxic effects of menazon treatment could be discerned in the foliage in late May, nor on the roots in December, and yield was unaffected.

Seedling populations were also assessed on four trials testing menazon seed treatment for aphid and yellows control. At Fowlmere, Cambridge, a Latin-square trial compared menazon seed treatment (estimated 7 oz a.i./acre) with 5% menazon granules at 9·2 and 16 oz a.i./acre placed in the furrow with the seed on 23 April. The seed was Sharpe's E graded to $\frac{7}{64}$–$\frac{11}{64}$, EMP-steeped and dieldrin-dusted. Seedling populations were unaffected by the menazon treatments. Green aphids were very few during June and July; black aphids were very unevenly distributed on the plots, and neither number of plants infested nor aphids were affected by treatments. Yellows incidence was only 4% in early September.

At Broom's Barn four replicates of 10 treatments were drilled with Bush monogerm seed, graded $\frac{6}{64}$–$\frac{8}{64}$, EMP-steeped and dieldrin-dusted in $\frac{1}{28}$-acre plots on 25–26 April. The following insecticide treatments were applied during drilling: menazon seed treatment (3·8 oz a.i./acre), 5% menazon granules drilled in the furrow with the seed (10 and 14 oz a.i./acre), 6·6% disulfoton granules drilled with the seed or applied in a band on the soil immediately ahead of the drill coulter (15 oz a.i./acre), seed pelleted with no menazon, or with 5% by weight (5·3 oz a.i./acre) or with 10% by weight (10·5 oz a.i./acre) of menazon on the original seed. These treatments were all compared with a demeton-methyl spray at 7 oz a.i./acre on 6 July.

One month after drilling, seedling populations did not differ significantly between treatments, but on the disulfoton plots the seedlings were stunted with scorched cotyledon tips, especially where the disulfoton was placed in the furrow with the seed. Aphids remained few throughout June, but both green and black species became more numerous in July; there were 5·5 and 254 per plant respectively on 22 July. Yellows incidence reached only 6% on the untreated plots in early September, and was slightly less with all insecticide treatments.

In the glasshouse seed pelleted with either 5% or 10% by weight of menazon before coating gave normal seedlings, and although aphids could not colonise them, they infected them with BYV.

Pelleted Bush monogerm seed, with and without menazon incorporated, was tested in the field near Harwich, Essex. Rates of menazon were nil, 1·5 and 2·9 oz a.i./acre and seedling populations were unaffected. The plots were drilled on 3 May and the treatment controlled aphids and yellows well. On 4 July the control plots had 3·7 green and 22·9 black aphids per plant, whereas the plots with menazon at 2·9 oz a.i./acre had 0·7 and 11·5. Half the plots were sprayed with demeton-methyl at 7 oz a.i./acre on 8 July. Yellows incidence on 29 August was 24%, compared with 16% and 9% respectively for the two rates of menazon without a later spray and 11%, 4% and 5% respectively when sprayed. By 25 September yellows

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incidence had nearly doubled on average, but the differences between treatments were less.

The same menazon treatments were tested in a trial at Bury St. Edmunds, sown on 22 April. Seedling and plant populations were unaffected. On 30 July menazon at 4·2 oz a.i./acre gave fewer green aphids per plant than the control, but less than 1% of plants had yellows on 12 September.

Seed treated with menazon powder has been included in field trials for 3 years (one in 1961, eight in 1962 and four in 1963) and its effect on yellows incidence in late August or September can be summarised by saying that when incidence is not more than 10%, which usually means infection arrived late, the treatment has little or no effect, whereas when incidence in untreated plots is more than 10% it is at least halved by the treatment.

A field trial at the Norfolk Agricultural Station, Sprowston, compared two rates of menazon and of disulfoton granules placed through knife coulters into the soil, 2·4 in. deep and 3·5 in. to the side of the beet rows on 29 May, before singling. On 18 June eight infected plants were planted in each plot to provide a source of BYV. Later treatments were disulfoton granules and demeton-methyl spray on the foliage on 27 June when the control plots had 1 green and 65 black aphids per plant. Green aphids on the control plots had increased to only 2·6 per plant on 31 July, when the treated plots averaged 0·8 aphids per plant. Black aphids increased rapidly during June and July, reaching a peak of 5,670 per plant on 31 July and then decreasing to only 1·1 per plant on 15 August. Menazon placed in the soil controlled black aphids better and for longer than the equivalent disulfoton treatments, but, as a foliar top-dressing, disulfoton was better than menazon. Demeton-methyl spray controlled black aphids well at first, but its effect did not persist as long as the other treatment.

Yellows incidence on the control plots was 10% in mid-August, rising to 76% at the end of September (385 infected-plant-weeks), and was decreased most by disulfoton top-dressing at 14 oz a.i./acre (51% decrease), followed by menazon placement at 29 oz, menazon top-dressing at 16 oz, demeton-methyl spray at 7 oz, disulfoton placement at 29 oz, disulfoton placement at 14 oz and menazon placement at 18 oz.

The control plots yielded 39 cwt/acre of sugar. Menazon placement (high rate) and disulfoton top-dressing increased yield by 16 cwt, menazon placement (low rate) and menazon top-dressing by 13 cwt, demeton-methyl spray 12 cwt, disulfoton placement (both rates) 11 cwt/acre of sugar. The passage of the knife coulters through the soil alongside the plants at the end of May did not affect yield.

Foliar top-dressings of phorate granules at 24 and 12 oz a.i./acre on 11 July, one spray of demeton-methyl at 7 oz a.i./acre on 5 June, and sprays on 5 June and 11 July were tested for possible effects on sugar yield in the absence of aphid damage and virus yellows; the 5 × 5 Latin-square trial was on a small, uniform area of beet at Broom's Barn. The $\frac{1}{261}$-acre plots were separated by 15 ft of row and 5 guard rows. Green aphids were rare on the plots throughout the summer; *A. fabae* on the control plots were fewer than 1 per plant at the beginning of July, but increased to 248 on 22 July, 780 on 8 August and then declined rapidly; the treated plots had fewer, but even on the control plots there was no obvious damage to the foliage by the aphids. At the end of September yellows incidence was only 2·5%. Yield on the control plots was 18·9 tons/acre of beet at 17·3% sugar, equivalent to 65·3 cwt of sugar/acre; treated plots yielded more, but not significantly so. (Dunning and Winder)

Yellows tolerant varieties. The outcrossed varieties N4S and 56/11, bred for yellows tolerance at Broom's Barn, were compared with commercial varieties and with other tolerant varieties in an experiment at Broom's Barn in co-operation with the National Institute of Agricultural Botany. The full results of this and similar experiments will be compiled by the NIAB. Sugar yield and sugar content of the uninfected Broom's Barn varieties were: N4S, 60·8 cpa and 17·6%; 56/11, 53·6 cpa and 17·6%; and on the plots artificially infected with BYV and BMYV; N4S, 40·3 cpa and 16·3%; 56/11, 37·7 cpa and 17·0%. The range of yields of the commercial varieties on the healthy plots were 48·1–55·8 cpa and 17·0–18·5%; and on the yellows plots, 33·3–37·3 cpa and 15·9–16·6%. The tolerant varieties equalled the sugar yield of the commercial varieties when uninfected and exceeded them when infected, but they contained less sugar when uninfected than the best of the commercial varieties, Klein Polybeet. (Hull and Glenister)

Downy mildew. The incidence of downy mildew (*Peronospora farinosa*), the course of development of the disease on individual plants, and its effect on root yield and quality were studied on a small crop of sugar beet at Broom's Barn, flanked by infected stecklings. Weather favoured mildew through most of the season, and the rate new infections appeared was constant from late June until mid-August, but then fell off, and few new infections occurred in September and October, although the weather remained favourable.

The greatest loss of root weight was in plants infected during June and July. The smallest sugar contents, up to 4% less than healthy plants, and the greatest juice impurity was in those infected in late July and early August. Plants infected before mid-June contained, on average, slightly more sugar than healthy roots, with juice only little more impure. Many recovered from the disease and appeared healthy for most of the growing season, and only differed from uninfected plants in being smaller.

In the glasshouse 25% of seedlings became infected when inoculated at the two-leaf stage by placing a drop of spore suspension on the growing point, compared with 2% of seedlings inoculated on the first true leaves, and 1·4% of seedlings inoculated on the cotyledons. When plants inoculated with downy mildew were incubated at constant temperatures between 3° and 20° C for 2 days there was little difference in the proportion that became infected, but above 20° C fewer did so.

Detached infected leaves incubated at 100% RH produced most spores between 9° and 13° C; very few were produced at 23° or 1° C, and none at 26° C. At 9° C there was little difference between spore production at 80 and 100% RH, but few spores were produced at 60 or 70% RH. The

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temperature at which the spores were produced did not affect their viability.

When spores were kept at constant temperature and humidity percentage germination was greatly decreased after 1 day at 18° or 23°C, but not after 2 days at 9° or 14° C. Survival of spores was not affected by varying the relative humidity between 100 and 60%. (Byford)

Seed treatment. In 19 replicated field trials ethyl mercury phosphate (EMP) applied at 1% vol/wt by the "Mist-o-Matic" machine gave 36% more seedlings per yard and 11% more plants in the final stand than untreated seed, compared with increases of 31%, 30% and 32% seedlings per yard and 8%, 9% and 9% more plants per chain given by EMP steep, an organo-mercury dust, and 2½% vol/wt "Mist-o-Matic"-applied EMP respectively. "Mist-o-Matic" EMP-treated seed was dried after treatment. In four additional trials seed dried before treatment with 1% vol/wt "Mist-o-Matic" EMP gave similar seedling emergence and final plant population to seed dried after treatment.

In seven trials where final plant population differed greatly according to seed treatment yields showed no constant relationship with plant population. (Byford)

Docking disorder. As in 1962, fieldmen and growers reported many fields where the sugar beet became stunted at singling time (*Rothamsted Report* for 1962, p. 113), and about half of all the samples received for identification were of stunted beet. Some were caused by soil acidity and some by faulty soil structure, but 88% were on light soil with an average pH of 7·0. Chemical weedkiller had been used on many affected fields, and toxic effects on the beet were suspected, but no evidence was found that this was the cause of the stunting. About 400 acres were reported affected, and the average affected area per site was 6½ acres. Some affected crops failed, but others recovered to give a moderate yield.

Stunted beet from 67 sites were studied, and a soil-borne virus transmitted by nematodes was isolated from 18 (see also Plant Pathology Department report, p. 106). Sometimes, although a virus was not isolated from the stunted beet, it was isolated from bait plants grown in the glasshouse in soil taken from around the stunted beet. Virus of the tomato black ring type was isolated from 12 sites in the Thetford–Attleborough–Diss area of Norfolk and of the tobacco rattle type from four sites in the same area and two sites in north-west Norfolk. In co-operation with the NAAS, field experiments testing cultural practices, which may have affected the incidence of the trouble this year, and soil sterilants, have been arranged in 1964 for two fields where the trouble was severe and uniformly distributed.

In several fields, mostly with loamy soil about pH 8 and which had recently carried a ley, beet were probably stunted for a different cause. The affected plants had a stunted tap-root and a bushy growth of laterals, and they occurred either in small, round sharply defined patches or in larger areas with a kite shaped, fairy-ring type of pattern. Virus was not isolated from these plants. (Heathcote)

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Sugar-beet manuring

This report gives the results of the 1962 co-operative experiments with the British Sugar Corporation; few results of the 1963 trials are yet known.

NK–salt trials. Thirteen trials were made in 1962, bringing the total to 42 in 4 years. The series is now concluded. The treatments used were 0·6 and 1·2 cwt/acre N, 0, 1·2 and 2·4 cwt/acre K_2O and 0, 2 and 4 cwt/acre salt in a factorial design, with 0 and 1·8 cwt/acre N tested in extra plots.

TABLE 1

Mean yields, averaged over all other treatments, in 42 trials in 1959–62 (Juice purity for 1960–62 only)

Treatment	N_1	N_2	Na_0	Na_1	Na_2	K_0	K_1	K_2
Rate (cwt/acre)	0·6	1·2	0	0·8	1·6	0	1·2	2·4
Clean beet (tons/acre)	16·5	17·3	16·3	17·1	17·4	16·7	17·0	17·1
Sugar (%)	16·8	16·4	16·5	16·6	16·6	16·4	16·6	16·6
Sugar yield (cwt/acre)	55·6	56·6	53·6	56·8	57·8	54·8	56·4	57·0
Juice purity (%)	94·15	93·68	93·94	93·91	93·86	93·96	93·87	93·93

On average, both nitrogen dressings were almost equally profitable (Table 1). Nitrogen interacted with sodium, and with salt the larger dressing was the more profitable. The full response curve, using the yields from the extra plots, showed 1·0 cwt/acre N to be most profitable dressing with salt; without salt it would be smaller.

Sodium and potassium also interacted. With the largest dressing of salt, potassium gives little benefit on average, but some fields give a good potassium response even with salt, and it would be dangerous to omit it entirely. Sodium is a highly important fertiliser, and 28 of 42 sites gave significant responses to it.

TABLE 2

Effects of combinations of two fertilisers, averaged over the third

Sugar yield (cwt/acre)

	N_1	N_2		N_1	N_2		Na_0	Na_1	Na_2
Na_0	53·6	53·7	K_0	54·5	55·1	K_0	51·2	55·8	57·5
Na_1	56·3	57·4	K_1	55·8	57·0	K_1	54·3	57·4	57·7
Na_2	56·9	58·7	K_2	56·3	57·7	K_2	55·5	57·2	58·2

Juice purity was greatly depressed by nitrogen. This element increases nitrogen and sodium in the juice considerably, and may increase potassium slightly. Sodium increased juice K and Na; potassium increased juice K but decreased Na. Both decreased juice N, and these effects largely cancel, leaving very little effect on total juice purity.

Straight versus compound fertiliser trials. These trials were attached to the NK–salt trials and have also ended. The treatments were given in the Rothamsted Report for 1962, p. 223. The plots with straight fertilisers yielded most in 7 out of 13 trials in 1962, with average increase of 1 cwt/acre of sugar. In both years straight fertilisers proved best in 19 trials out of 26, the mean difference in yield being nearly 2 cwt/acre sugar. A series of more complicated trials testing compound and straight fertilisers was made in 1963.

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Nitrogen top-dressing trials. The design of these trials was altered slightly from previous years. The treatments were 0, 0·6, 1·2 and 1·8 cwt/acre N on the seedbed, 0·6 and 1·2 cwt/acre on the seedbed plus 0·6 cwt/acre top-dressed, and 0·6 cwt/acre plus 1·2 cwt/acre during the previous autumn either before or after ploughing. The 0·6 and 1·2 cwt/acre N on the seedbed gave the greatest yields and were equally profitable. 1·8 cwt/acre N decreased both the sugar percentage and yield. On average, top-dressing was inferior to applying the same total dressing in the seedbed, the yield difference being about 1 cwt/acre sugar. The autumn applications gave smaller yields than the best treatments, but better than spring applications of 1·8 cwt/acre N, probably because excess nitrogen leached during the winter. Applying nitrogen after ploughing was better than before.

This series has now ended. Some mean yields over the whole series are given in Table 3. Top-dressing clearly gives a smaller yield than placing the same total amount in the seedbed.

TABLE 3

Mean yields of sugar in 34 trials 1959–62
(*comparable treatments only*)

Top-dressing N (cwt/acre)	Total N (cwt/acre) 0	0·6	1·2	1·8
	Sugar yield (cwt/acre)			
0	48·1	57·5	58·7	57·9
0·6	—	—	57·3	57·0

Magnesium trials. This series of factorial experiments tests magnesium, ammonium, potassium and sodium sulphates; five trials were made in 1962. The optimum N dressing was 1 cwt/acre, and the application of all the other fertilisers at the rates tested was highly profitable, giving mean responses of 4·4 (K), 5·5 (Mg) and 5·3 (Na) cwt/acre sugar. Again the response to magnesium (as 5 cwt/acre kieserite) differed widely between trials; the greatest response was 13·0 cwt/acre sugar. Magnesium depressed α-amino nitrogen, sodium and potassium slightly in the root juice, giving a slight improvement in juice purity; the other fertilisers, particularly nitrogen, depressed purity.

Nitrogen interacted with sodium, and potassium with sodium, as usual; magnesium and potassium did not interact, but magnesium and sodium interacted positively. Sodium also intensified magnesium deficiency symptoms on most trials; there is thus a sodium–magnesium antagonism. Magnesium gave a smaller yield increase in presence of large nitrogen dressings, indicating a strong negative nitrogen–magnesium interaction. This effect was much greater on yields of tops than of roots or sugar, and agrees with the observed lessening of magnesium deficiency symptoms by large nitrogen dressings. Nitrogen may cure the leaf symptoms even when root yield is increased slightly by magnesium.

Nitrogen requirement prediction. The average optimum dressing for sugar beet has been firmly established as about 1 cwt/acre N, but a proportion of fields need more. Many farmers still use dressings well above

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the optimum, and the uncertainty about the requirement of a particular field makes it more difficult to dissuade them from this. The possibility of predicting the requirement of particular fields has been studied over the last 3 years.

A soil incubation technique (Gasser, J. K. *J. Sci. Fd Agric.* (1961), **8**, 562) was applied to soil samples from the 1961 NK–salt and nitrogen top-dressing and 1962 top-dressing series of trials. The results were very irregular, but a correlation coefficient of —0·65 was found between nitrate produced on incubating air-dried soil and optimum nitrogen dressing in the 1962 top-dressing experiments. The main difficulties in this work are the irregular response curves found in many of the field trials, and the predominance of trials with an optimum nitrogen dressing about the average level of 1 cwt/acre. These are of little use in work on the detection of fields with unusual requirements for nitrogen.

In 1963, 18 trials tested the effects of five levels of nitrogen, for comparison with soil incubation tests. The extraction of soil carbohydrates by $Ba(OH)_2$ solution (Jenkinson, *Rothamsted Report* for 1962, p. 61) is also being tested on the same samples, and this method is now being used in an attempt to select fields unusually rich or deficient in nitrogen for trials in 1964. (Tinker)

Broom's Barn Farm

The wet spring showed up several places where land drainage was inadequate. In the autumn a clay basin in Little Lane was tile-drained into the dyke on the east boundary of the farm; a soakaway was dug at the low point where the concrete road crosses the windbreak, to take water from roadside gulleys and short land drains; a second, larger soakaway was dug at the north end of the roadside dyke, where water overspilled last spring on to the fields alongside the railway.

Surveys. The Ministry of Agriculture Survey Section kindly resurveyed the farm in May, and permanent sockets now mark all the places where grid lines cross the concrete roads and appropriate field boundaries. Mr. G. H. Brenchley kindly arranged for the farm to be photographed on infra-red film from the air during the summer. The photographs revealed numerous interesting variations in crop density. The original farm tracks, filled pits, levelled banks and tree-stump sites showed clearly as expected, but another track system proved to be the one serving the old "open fields" as shown on a map of the area before enclosure. This map also shows a copse called Brome Close, and the northern S-shaped edge showed clearly on the photograph in the barley on Brome Pin. A surprising feature was the striking pattern of plots and pathways of last year's sugar-beet experiments on this year's barley. On several slopes there are the striations attributed to solifluction into crevices made by the ice-age permafrost. The ryegrass on Flint Ridge, which had been recently irrigated, showed a striking pattern of growth from uneven water distribution. The wild oats in the barley on Hackthorn showed clearly in the photos. (A map of Broom's Barn farm is to be found at the end of the Report.)

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Cereals. The winter wheat var. Cappelle on Dunholme had water flowing over it and was flooded for several days at the end of February when the snow melted. However, the ground was still frozen and the crop was not damaged. The average yield of 32½ cwt/acre of grain was depressed by rabbit damage alongside the railway and on the slope at the south-east corner by drought in July.

The barley, var. Rika, yielded 35, 33 and 34 cwt/acre on Brome Pin, Hackthorn and Little Lane respectively. On Brome Pin, F. V. Widdowson tested the effect of different forms, placings and dosages of nitrogen and of salt. Plots receiving 70 units of N lodged and yielded less than those with 35 units of N, which increased yield by 3·0 cwt/acre. Mean yield was 37·4 cwt/acre. Hackthorn was not sprayed against wild oats because few were seen in the spring, but eventually they proved to be numerous and the field would have been better sprayed. Spraying kept Little Lane free from wild oats. The losses of grain from heads which broke off in the wet, stormy, August weather, which delayed harvest, were probably considerable. All the grain had to be dried after initial storage on the barn floor.

Sugar beet. The wet spring delayed seedbed preparation and sowing started on Black House, the site of most experiments, on 8 April and finished on 6 May. Bull Rush was sown on 23 April. Precision drills sowing rubbed and graded seed at 2-in. spacing, and band-spraying with "Murbetex" pre-emergence weedkiller gave weed-free, uniform brairds which were singled by hand, resulting in an even stand of about 30,000 plants per acre. Most of the beet had 1½ in. of irrigation water in July, after which it had ample rain. Some was sprayed in June to control mangold fly and in July to control black aphids. Harvesting started at the end of September and was completed in mid-December. The mean yield was 14·7 tons/acre at 17·1% sugar content. Mr. G. Cussans, Norfolk Agricultural Station, obtained very striking effects from both pre- and post-emergence weed-control chemicals on Black House. In May, before hoeing, the contrast was between clean full brairds of vigorous beet on some of the treated plots, whereas in untreated plots the rows of beet could scarcely be seen they were so thick with weeds.

Time of sowing and harvesting. The first sowing on this experiment was delayed until 8 April because of wet weather. Wild oats were more numerous on the early than on the late-sown plots, and in July more

TABLE 4

Yield of sugar from beet sown and lifted on different dates
Black House Field, 1963

	Lifting date									
	23 Sept.		14 Oct.		12 Nov.		6 Dec.		Mean	
Sowing date	cpa	%	cpa	%	cpa	%	cpa	%	cpa	%
8 April	58·2	16·5	72·2	17·8	78·0	17·5	80·3	17·3	72·2	17·3
23 April	49·9	16·5	63·6	17·8	69·8	17·6	72·6	17·4	64·0	17·3
6 May	49·5	16·4	58·1	17·7	66·9	17·5	69·3	17·5	60·9	17·3
Mean	52·5	16·5	64·6	17·8	71·5	17·5	74·1	17·4	65·6	17·2

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black aphids infested the late than the early sowings. Early sowing gave the greatest yield of sugar per acre (Table 4), and yields increased progressively with later liftings. Sugar percentage was largest at the second lifting, but changed little after this. Sowing date did not affect sugar percentage.

Spacing and variety. Z-varieties, which have a larger sugar content than the widely grown E-varieties, yield less sugar per acre when grown in the conventional way. The factories prefer roots rich in sugar, and, with the present price structure, Z-varieties would be more profitable to the grower if they gave as much sugar per acre as the E-varieties. The object of this experiment was to determine how the yield of Sharpe's Klein E and Klein Z varieties compared at different plant populations. Much previous work has shown little benefit from increasing plant population in 20-in. rows above 30,000/acre, so in this experiment plants in beds of 5- × 10-in. rows, bordered by 20-in. rows down which the tractor wheels could run, were compared with the conventional 20-in. rows. Plants in the 20-in. rows were spaced at 10 in. and in the 10-in. rows at 12 in. or 8 in., giving plant populations (allowing for the 20-in. tractor wheel rows) of 31,000, 44,000 and 65,000/acre. Sowing on 27 April and harvesting on 29 October gave a growing season of only 26 weeks. The plants on plots with large populations appeared to be short of water in July, and the whole experiment was given 1½ in. of irrigation water. The 10-in. row plots had complete ground cover 3–4 weeks earlier than 20-in. row plots, and weed control on them was easier. Yields were assessed by the usual tarehouse procedure.

Sharpe's E gave the greatest sugar yield, and increasing the plant population decreased yield but did not affect sugar percentage. Increasing the plant population of Klein Z did not appreciably affect sugar yield and sugar percent. Sharpe's E gave a mean sugar yield and sugar content of 66 cpa and 17·9% respectively and Klein Z gave 62 cpa and 19·3%. Increasing the nitrogen application from 100 to 180 units depressed sugar yield and sugar content of both varieties at all spacings. These results do not entirely parallel those from periodic samplings from the plots by P. J. Goodman (see p. 85), who found that the larger plant populations gave greater yields of dry matter. In the agricultural yield determinations small roots are lost in the washer, and of those recovered from the washer 30% of roots (11% of root weight) from plots with large populations weighed less than 5 oz, compared with 3 and 0·6% respectively from plots with small plant populations. Close spacing increased the proportion of total dry matter in the tops. In future experiments a more suitable variety than Klein Z for this purpose will be sought.

Farmyard manure and gypsum. A good seedbed was prepared on the Streatham series on Bull Rush at the end of March, but it could not be sown because frequent rain kept it too wet. At the end of April it was pulled up with harrows and sown while rather rough. In spite of this, gypsum at 3 tons/acre gave no better seedbed and had no effect on yield, sugar content or juice purity with or without salt, and with heavy or normal fertiliser dressings. Although farmyard manure alone did not increase yield,

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with fertiliser it yielded better than fertiliser alone. Increasing the dressing of fertiliser did not affect root yield, but decreased the sugar percentage. Gypsum applied to Hackthorn field for sugar beet in 1962 had no effect on yield of barley in 1963.

Grass, forage and miscellaneous crops. S22 ryegrass on Flint Ridge gave 4 tons/acre of silage when cut in early June, 3 tons/acre in mid-July and a supply of green fodder which was carted to the yard-stock in the autumn. It had 1⅓ in. of irrigation water after the first cut. It will be cropped again in 1964.

Marl Pit gave 6 tons/acre of oat and tare silage in early July. It was then twice cultivated 14 in. deep, worked down and levelled before sowing with winter wheat.

The S53 meadow fescue on White Patch gave 3 cwt/acre of cleaned seed and 1,000 bales of rough hay. The sward was broken up and sown with winter wheat.

Cover crops tested in conjunction with the National Institute of Agricultural Botany were sown in early July on fallow land. As last year, the cruciferous crops established first and produced most harvestable dry matter. Turnips produced 65, fodder radish 60, white mustard 45 and rape 38 cwt/acre of dry matter. The rye was badly damaged by frit-fly. The leguminous crops, which included *Trifolium alexandrium*, were slow to establish, but eventually gave a good stand, which was grazed by pests and yielded only 10–14 cwt/acre of dry matter.

Rotation experiments: subsoiling. The plots which were subsoiled in August 1961, this year yielded more than those which were not. The increases from subsoiling were wheat 0·9, barley 1·0 cwt/acre of grain, lucerne 0·9 cwt/acre of dry matter and sugar beet 0·65 tons/acre of roots and 1·9 cwt/acre of sugar. Only the effect on sugar beet was significant, and it was similar to that measured in 1962. The plots receiving above-normal fertiliser dressings this year outyielded the below-normal fertiliser plots by 2·7 cpa of barley, 1·3 cpa of wheat, 0·5 cpa of Lucerne dry matter, 0·67 tons/acre of sugar beet, but sugar percentage was depressed 0·9 and sugar yield 1·1 cwt/acre.

Livestock. The 58 cattle overwintered in the yard were sold between February and May at an average live weight for the Friesians of 8¼ cwt, and Hereford cross 7¾ cwt, and their mean live weight increase per head during the winter was respectively 2 and 1¾ lb/day. They produced 60 tons of farmyard manure, most of which was ploughed into Marl Pit in the autumn.

In the autumn 76 head of Hereford-cross cattle weighing on average 5·4 cwt were bought. At first they had aftermath ryegrass from Flint Ridge, but this soon became too fibrous and they did not flourish. Beet tops were then carted to them until mid-December, and they thrived on them with home-grown barley and protein mixture for concentrates. From mid-December they have had self-feed silage with 8 lb/head of barley per day.

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