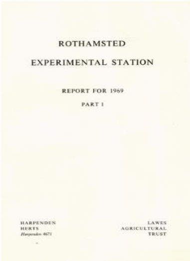
Report for 1969 - Part 1

Full Table of Content


ROTHAMSTED
EXPERIMENTAL STATION
REPORT FOR 1969
PART 1

Broom's Barn Experimental Station

R. Hull

R. Hull (1970) *Broom's Barn Experimental Station ;* Report For 1969 - Part 1, pp 308 - 338 **- DOI: https://doi.org/10.23637/ERADOC-1-124**

BROOM'S BARN EXPERIMENTAL STATION

R. HULL

Our work on the sugar-beet crop ranges over growing practices and nutrition, seed production and how the quality of seed influences the growth of the crop, pests and diseases and their control. As control methods are developed and adopted the most damaging pests and diseases tend to wane and others develop or become relatively more important. Wireworms and flea beetle seldom now damage crops but millipedes, symphylids, slugs and birds are a menace to progress in eliminating handwork by seeding thinly. Control of yellows and downy mildew need improving although these diseases have not been prevalent for several years. The development of new fungicides and methods of application offer hope of controlling the leaf spots and the newly prevalent powdery mildew which destroy leaves in the late summer. The dramatic improvement in growth obtained by soil fumigation to prevent damage to roots by nematodes and fungi has emphasised the importance of a healthy and vigorous root system. Roots are not restricted only by pests but by soil structure and composition. The effects of soil compaction on yield and response to nutrients described below are greater than we expected. The environment in the soil often limits yield and an increasing part of our work is concerned with investigating the factors influencing development and functioning of roots in soil.

Yellows and aphids in sugar beet

Mean air temperature in eastern England during February was 5·2°F and during March 4·0°F colder than average, which augured that aphids would arrive late in the beet crop and yellows would not be prevalent. Green aphids were few on winter hosts, but eggs of *Aphis fabae* were numerous on spindle near Broom's Barn. The soil remained wet throughout the autumn, winter and spring; this delayed sowing and only 5% of the national sugar beet acreage was sown in March and over 20% after 26 April. Few green aphids infested beet at first but they developed rapidly during hot, dry weather at the end of June and growers in Essex were advised to spray their crops with insecticide. During July black aphids became prevalent; about 340 000 acres of sugar beet were treated with systemic insecticide to control them. This also restricted the spread of yellows and at the end of August the average percentage of plants infected in all sugar-beet crops was 3·5, less than half that expected from the forecast based on winter weather. This is the smallest percentage since 1963, and for eight consecutive years it has been less than 10%.

Control by sprays and seed treatment. Five trials in eastern England compared the incidence of yellowing viruses and of aphids in unsprayed plots and in those sprayed when a warning was sent to growers in the area. For

https://doi.org/10.23637/ERADOC-1-124

half of the plots menazon (4% by weight of the seed) was incorporated in the middle layer of the pelleting material on Amono seed. Aphids were few on plants in mid-June but on average menazon-treated plants had only half as many as untreated plants. By 8 July, green aphids were numerous on experiments at Cantley and Ely but very few near Spalding, and the numbers differed little in treated and untreated plots. At Felsted, however, green aphids averaged five/plant on those from untreated seed and one on plants from treated seed. Black aphids, which were numerous at Spalding and Bury St. Edmunds, were not controlled by the menazon.

Only at Felsted and Ely did more than 20% of the untreated plants have yellows by the end of September, and neither treating the seed with menazon nor spraying with an aphicide greatly affected the percentage. On average, unsprayed plots yielded more beet without the seed-treatment than with it, and the largest yields were from plots sprayed when a warning was issued.

A trial with *var*. Amono at Broom's Barn, and another with *var*. Monotri in Sussex, gave similar results. Menazon incorporated in the pellet, or sprayed on the pellet before sowing, partially protected against the few aphids that infested the plants early in the season, but the largest yields and the best control of yellows was obtained by spraying with demeton-s-methyl when a warning was issued in the area. Black aphids damaged plants from both untreated and menazon-treated seed in Sussex.

A trial at Broom's Barn and six in different sugar-factory areas compared the germination of Monotri and Amono sugar-beet seed pelleted by the Germain process, with or without menazon. In November 1968, or February 1969, 4% menazon by weight of the seed was incorporated in the middle layer of the pelleting material. With menazon slightly fewer seedlings emerged, and fewer with early than late pelleting, but the differences were not significant. (Heathcote)

Control by aldicarb. In a trial at Broom's Barn, sown on 28 April, aldicarb ('Temik') applied as granules with the seed at 24 oz a.i./acre, and demeton-s-methyl spray at 3·4 oz a.i./acre, applied early or late, were compared alone and in combination for the control of aphids. Natural infestation was slight early in June, and 10% of the plants in the centre area of the plots were artificially infested on 18 June with *A. fabae* from a beet crop. Apterous black and green aphids/plant on the plots without aphicide numbered 14 and 2 on 26 June, 14 and 9 on 1 July, 84 and 17 on 11 July, 908 and 146 on 17 July, but only 58 and 4 on 24 July; aphids disappeared soon after because of migration and disease rather than parasites or predators. Aldicarb controlled aphids very effectively until mid-July (11 weeks after sowing), but on 17 July there were 62 black and 6 green apterae/plant (6·3 and 4·3% of the population on untreated plots); numbers declined thereafter faster than on the untreated plots. Demeton-s-methyl spray on 26 June controlled aphids effectively at first, but less well in late July than the aldicarb applied during drilling. Demeton-s-methyl applied on 18 July controlled aphids fairly effectively for the remainder of July. The best control was by aldicarb granules followed by sprays on

https://doi.org/10.23637/ERADOC-1-124

26 June and 18 July. Despite the large infestation of *A. fabae*, the vigorous crop seemed not to be harmed. Virus yellows was very patchily distributed by early September, when all treatments decreased it from 10 to 3–4%. No treatment altered sugar yield, which was 60·3 cwt/acre on the untreated plots.

The persistence in sugar beet foliage of the insecticidal action of aldicarb, menazon and methomyl was compared. Single-row plots were sown on 9 April and 2 May with Amono pelleted seed incorporating menazon (2 oz a.i./acre), or untreated but with granules of menazon (7 and 29 oz a.i./acre) in the seed furrow, or aldicarb (9 and 35 oz a.i./acre), or a solution of methomyl (1·3 oz a.i./acre). *A. fabae* were caged at intervals on the plants until mid-June and the dead ones counted after 24, 48 and 72 hours. For comparison, and to test persistence later, inner and outer leaves were collected on 2, 16, 18 and 27 July, stored in a freezer, pulped, and male *Drosophila melanogaster* caged over the pulp; the *Drosophila* killed measured the total insecticidal effect of the leaf pulp.

Sowing date had no consistent effect on the number of caged aphids killed so the counts for different sowing dates were pooled. On 22 May all caged aphids were dead within 3 days on plants given the larger amount of aldicarb or menazon granules, and by menazon incorporated in the pellet, but not by the smaller dressing of granules. On 9 June both dressings of aldicarb granules, and the menazon incorporated in the pellets, killed 80% of the aphids within 1 day and almost 100% within 3 days, but menazon granules killed fewer.

Standard leaf-pulp samples containing 5 ppm aldicarb killed all the *Drosophila* within 40 hours and 65% were killed by 1 ppm; the same concentrations of menazon killed 55 and 50% (10 ppm needed to kill 100%) and methomyl killed 55 and 40% (50 ppm needed to kill 100%). The inner leaves taken from the field on 2 June and 27 July were more insecticidal than the outer ones, but on 16 and 18 July the outer leaves were more insecticidal. On 2 June, but not consistently later, many more *Drosophila* were killed by the leaf pulp from the early sown (54 days old) than from the late sown beet (31 days old). Of samples taken on 18 July, only those from plants with the larger dressing of aldicarb and menazon killed many *Drosophila*; none of those taken on 27 July killed more than 40%, and most were killed by samples from plants that had menazon in the seed pellet. At all dates tested, 2 oz menazon in the seed pellet gave more insecticidal activity than 7 oz as granules in the seed furrow, confirming the results of earlier field trials. (Chalk, Winder and Dunning)

Mangold clamp and weed survey. Fieldmen from the sugar factories examined 429 mangold clamps for infesting aphids during late April; 52 were infested, half as many as in 1968, and only one heavily. Of 34 clamps (three of which contained *Myzus persicae*) from which aphids were tested, one contained some infective with BYV and four some infective with BMYV.

Aphids of various species were on 43% of the weeds collected by fieldmen alongside fields where beet was grown in 1968, but *M. persicae* were on only 7%. Aphids from eight sites were infective with BMYV.

https://doi.org/10.23637/ERADOC-1-124

Aphids. Eight sticky aphid traps in sugar-beet root crops caught on average four times as many aphids as during 1968; many were *Cavariella aegopodii*. No *M. persicae* was trapped during May and few during June, and fewer in total than in 1968, but more *A. fabae* were trapped than in any year since 1963. Few of the aphids that infest beet were caught by three traps in sugar-beet seed crops to the west of the Great North Road.

Unusually many syrphid flies were trapped in eastern England during mid-August, but other predators of aphids were not exceptionally abundant.

Beet seed crops became only lightly infested with *A. fabae* and few were treated with insecticides. Spindle bushes near Newmarket were heavily infested with overwintering eggs of *A. fabae* and a bad attack of 'blackfly' was expected, but eggs were fewer elsewhere and there was unfavourable weather when alatae left crowded bushes. *M. persicae* overwintered on one seed crop on the Huntingdonshire–Bedfordshire border which was not sprayed in 1968. (Heathcote)

Yellows in seed crops. In June, 60 crops distributed in all seed growing areas had on average 3·7% plants with yellows. The average was increased by three open *in situ* crops in the Bedfordshire–Huntingdonshire area which were infected late in 1968 and showed no yellows when inspected in October, but did in the spring. Open *in situ* crops in the Cotswolds had fewer infected plants than expected from the autumn counts, because infected plants were either killed by frost or smothered by competition from healthy plants in the dense stand of the direct-drilled crops. Only occasional crops had plants with downy mildew; the average infection was 0·34%. Yellows was scarce in steckling beds in the eastern counties during October, and most of those raised under cereal cover crops were free from viruses. The average incidence of yellows in 148 stecklings beds was 0·11% and no plant with downy mildew was recorded. Most of the 21 crops in the Cotswold area were healthy and vigorous, but disease was prevalent in two. In one, sown on 1 July, about 10% of plants emerged quickly but the remainder came later after rain. The plants emerging early were infected with yellows by the heavy infestation of aphids in July. (Byford)

Preference shown by *M. persicae* for plants with yellowing viruses. On four occasions apterous *M. persicae* were caged in the dark and given the choice to settle on detached leaves from uninfected sugar beet or on leaves of equivalent age from beet infected with BYV or BMYV. After 24 hours significantly more aphids had settled on the infected than on the uninfected leaves, and also more on leaves with BYV than on those with BMYV. (Heathcote)

TABLE 1

Log. number of M. persicae*/leaf after 24 hours*

Healthy	BYV	BMYV	Mean	S.E.
0·18	0·93	0·42	0·51	±0·058

https://doi.org/10.23637/ERADOC-1-124

Seedling pests and diseases

Pitfall trapping. Pitfall traps of 450 ml capacity, with an aperture of 5 cm diameter and a 1 cm lip, were placed in experiments on Little Lane (clay loam) and on Brome Pin (sandy loam). They were emptied weekly between 29 May and 14 September. There was no consistent difference in catches, either between the insecticide-treated and untreated plots on Little Lane or between the plots of continuous beet and of beet after four barley crops on Brome Pin. The averages for the two sites are given below.

The only pest species caught, other than aphids, were pigmy beetle (*Atomaria linearis*) and, very rarely, mangold flea beetle (*Chaetocnema concinna*). Pigmy beetle was much less numerous on Little Lane than on Brome Pin. Carabids, especially *Feronia melanaria*, were by far the most numerous of the predatory insects caught. *F. melanaria* never exceeded 35/trap/week on Brome Pin and was usually fewer than 20; every week considerably more were caught on Little Lane, where they reached a peak of 109/trap during the week ending 23 July. In six traps changed at 8-hourly intervals for 48 hours, 120 were caught between 21.00 and 05.00 hours, but only two between 05.00 and 13.00 hours and three between 13.00 and 21.00 hours. Whether they have any beneficial effect in the sugar beet crop is not known.

The number of carabids caught increased through the trapping period and 12 genera were identified. Collembola, which were very numerous during May and June, were fewer later. Staphylinids were fairly frequent throughout the season and six genera were identified. Coccinellids were surprisingly rare, despite the aphid infestations on both sites. (Chalk and Dunning)

Defoliation. The trial described in the *Rothamsted Report for 1968*, Part 1, 273, was repeated. Seed was sown on 14 April and plants were defoliated at monthly intervals from mid-May to mid-October. Aphids became equally numerous on the undefoliated plots in July (119 green and 844 black apterae/plant) whether with or without nitrogen. The plots were sprayed with demeton-s-methyl on 18 July; no obvious damage was caused by the aphids so late in the season, and yellows incidence was negligible at the end of August. Table 2 gives the yields on 21 November. August defoliation decreased yield most on the plots with nitrogen, as in 1967 and 1968, but July defoliation decreased yield most on the plots without nitrogen, as in 1968 (not tested in 1967). October defoliation, one month before harvest, did not alter root weight, but decreased sugar content 1·5%. July and September defoliation gave the smallest root weight and sugar content respectively. The results more resembled those of 1967 than 1968, as both sugar content and root yield were decreased by defoliation. (Dunning and Winder)

Seed and soil treatment with insecticide. Eighteen main trials and other subsidiary ones in the different factory areas tested various fungicides, insecticides and nutrients incorporated during pelleting of Amono monogerm seed. All treatments were also tested at Broom's Barn.

https://doi.org/10.23637/ERADOC-1-124

TABLE 2

Sugar yields and percentage decrease in yield from completely defoliating plants sown on 14 April and harvested on 21 November

	With N		Without N	
When defoliated	Sugar yield cwt/acre	Decrease %	Sugar yield cwt/acre	Decrease %
Not defoliated	60·4	—	49·8	—
20 May	58·0	4·0	42·7	14·3
17 June	51·8	14·2	39·7	20·3
16 July	45·4	24·8	30·3	39·2
14 August	38·4	36·3	32·2	35·3
16 September	45·0	25·5	35·9	27·9
15 October	55·2	8·7	45·2	9·2

L.S.D. for sugar yields, horizontal and vertical comparisons, 3·71 (5%), 4·93 (1%), 6·41 (0·1%).

In the main factory trials, dieldrin (0·1, 0·2 and 0·4% a.i. by weight of seed) and formulations (seed dressing *vs* wettable powder) were tested on sites where seedling establishment was likely to be difficult. There were significant increases in seedling population with one or more dieldrin treatments at Bardney, Felsted and King's Lynn (pest damage not observed), Ely (pigmy beetle and millipedes) and at Peterborough (millipedes and wireworm). Plant population was increased at Ely, Felsted and Peterborough. Dieldrin at 0·1, 0·2 and 0·4% increased plant populations 2·4, 1·5 and 3·7% respectively when compared with the untreated seed (EMP steep only). The 70% wettable powder formulation at 0·2% a.i. on the seed gave similar results to the standard 40% dressing at the equivalent rate.

It made no difference to the field results whether the dieldrin was applied to the seed by the seed merchant before delivery to the pelleting plant, or during the early stages of pelleting; it was applied to 15 tons of seed by the seed merchant and to 1 ton during pelleting, and each carried 2030 ppm dieldrin/seed weight (target dose 2000 ppm—analyses by the British Sugar Corporation Research Laboratory).

Increasing the dieldrin in the pellet to 3·2% a.i. by weight of seed, 16 times the usual commercial dose, failed to affect seedling emergence, plant population or vigour of a crop at Broom's Barn. After 6 months storage germination was still unaffected by even the largest amount of dieldrin.

'Ciba C 10015', 'Dursban' and 'Lannate' (methomyl) at 0·5 and 2% a.i. by weight of seed, isobutyridene diurea (IBDU) at 1·2, 6 and 30% N by weight of seed, and triple superphosphate at 0·5, 2 and 4% P by weight of seed, were also incorporated experimentally during pelleting by Messrs. Germains Ltd. No treatment affected germination when tested in March in the laboratory, or the number of abnormal plants produced, but in September the larger amount of 'Dursban' decreased germination from 86 to 66% and increased 'abnormals' from 5 to 22%. With the larger amount of IBDU only 2% of the seed germinated and 'abnormals' were 88%; no other treatment had any adverse effect after 6 months' storage. Seedlings from untreated seed were not damaged by pests at Broom's Barn and in these conditions none of the treatments improved seedling

https://doi.org/10.23637/ERADOC-1-124

emergence or plant population and 'Dursban', especially the larger dressing, decreased both.

These treatments, and dressings of dieldrin from 0·1 to 3·2% incorporated during pelleting, were tested at four Fen sites where pest damage was expected, on soil types ranging from peat to silt. Although millipedes and pigmy beetle were present, they caused no loss of plants. No treatment increased seedling or plant numbers, which on average were fewer with the larger amount of 'Dursban' and IBDU. At two of these sites, Seventh Drove, Ely (peat) and Nordelph, Wissington (silt), some of these pesticides and others were tested as solutions or suspensions trickled into the furrow with the seed during sowing, to give 1 and 16 oz a.i./acre: 'Dursban', 'Ciba C 10015', 'Geigy GS 13006', DDT, diazinon, fenthion, γ-BHC, heptachlor, mecarbam, methiocarb and methomyl. At both sites the larger amount of methomyl depressed seedling and plant numbers, and vigour. At the peat site, seedlings were fewer with the larger amount of 'Dursban', γ-BHC, fenthion, heptachlor and mecarbam. No other treatment had an adverse effect; the smaller amount of methiocarb increased plant population on the silt site and that of heptachlor increased seedling numbers and vigour on the peat. (Dunning and Winder)

Seedling diseases and fungicide seed treatment. In trials with pelleted seed at 18 centres (p. 312) EMP steep was compared with maneb (19·2 oz a.i./cwt seed applied either as a powder in the pellet, or as a slurry on the seed before pelleting). The protectant fungicides dichlone (6 oz a.i./cwt), 'Dexon' (6 oz a.i./cwt) and benomyl (4 oz a.i./cwt) were applied to EMP steeped seed to see whether the crop benefited from controlling soil-borne in addition to seed-borne fungi. Maneb dust and slurry gave similar seedling emergence and final plant population to EMP steep. The protectant fungicides gave at best small increases in mean seedling emergence and final plant stand, but nowhere conferred any obvious benefit to the crop.

In trials at Broom's Barn and near Ipswich, the above fungicides were tested together with 'RH 893' (5 oz a.i./cwt), captafol (11 oz a.i./cwt) and benomyl (6·9 oz a.i./cwt) all applied to EMP steeped seed. Most treatments gave slightly more seedlings and better final stand than EMP steep alone, but not enough to justify their use. 'RH 893' slightly decreased both emergence and final stand. The trial at Broom's Barn was harvested on 7 November, when maneb dust and slurry both gave 5% more sugar than EMP steep, and 'RH 893' gave 5% less. The other treatments did not affect yield.

Blackleg was prevalent during spring, and occurred in crops up to 12 July, much later than usual. Twenty-four samples of seedlings with blackleg were received at Broom's Barn from nine factory areas. Of the 11 received during May, five were infected with *Phoma betae* and two with *Aphanomyces cochlioides*, whereas of those received during June, 12 had *A. cochlioides* and three *P. betae*. *A. cochlioides* is seldom so prevalent in England, and 1969 contrasts with 1967 when it was in only four of 30 blackleg samples, and 1968 in two of 20 samples. Late drilling and wet soil, common in 1969, are both factors that favour *A. cochlioides*. Seedlings grown in pots of soil from a field where a sugar-beet crop was severely

https://doi.org/10.23637/ERADOC-1-124

damaged by the fungus were heavily attacked. In late September the Ely factory fieldmen collected soil from 35 fields selected at random. Seed known to have little *P. betae* was sown in these soils in the glasshouse, and all seedlings that damped off were incubated for 48 hours in shallow sterile water. *A. cochlioides* developed on seedlings from three soils.

In a field where a crop severely attacked by *A. cochlioides* was ploughed up, a trial sown on 2 June compared the same treatments in pelleted seed as in the trial at Broom's Barn described above. All treatments gave more seedlings than untreated seed; the best was dichlone which gave 18% more. However, when samples of seedlings were examined for blackleg, only 'Dexon' clearly increased the proportion of healthy seedlings; it gave 29% more healthy seedlings per yard than untreated seed, and the next best, benomyl (4 oz a.i./cwt), gave 17% more. At harvest none of the treatments increased sugar yield. (Byford)

Leaf diseases

Downy mildew. The resistance of different sugar-beet varieties to downy mildew 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 disease was encouraged. Spraying with 'Betanal' in early June severely scorched the leaves and only partially controlled weeds. The proportion of plants infected with mildew during the season ranged from 36% to 62% in different varieties. Differences between varieties were smaller than previously because relatively more plants of the resistant varieties had mildew, but the order of susceptibility of varieties resembled that in other years. Those with fewest infected plants were Amono, Anglo Maribo Poly, Battles E, Hilleshog Monotri, K. W. Erta, Sharpe's Klein E and Sharpe's Monogerm, and those with most were Bush Mono, Hilleshog and Maris Vanguard.

Single rows of five varieties were sown at 24 sites in root crops near seed crops in south Lincolnshire, West Norfolk and Cambridgeshire. Downy mildew was rare in all except one crop and nine were free from the disease. The mean proportion of infected plants at the other 15 sites was: Hilleshog 3·3%; Maris Vanguard 2·8%; Sharpe's Klein Polybeet 1·7%; Sharpe's Klein E 0·8% and Anglo-Maribo Poly 0·8%, the same order of susceptibility as at Trawscoed. (Byford)

***Ramularia* leaf spot.** An open direct-drilled seed crop at Stonesfield, Oxfordshire, was used to study the effect on leaf spot of one, two or three sprays of fentin hydroxide at 0·4 or 0·6 lb a.i./acre, or one or three sprays of benomyl at 0·25 lb a.i./acre, given between 28 April and 29 May. The percentage leaf area covered by spots was estimated on the lower leaves from 100 plants/plot on 19 June, and on 100 mid-stem leaves/plot on 16 July. The crop was harvested on 27 August. *Ramularia* began to spread rapidly during June. Later the crop was affected by drought and at harvest many plants had *Phoma* foot rot. Both fungicides controlled leaf spot and on 16 July whereas leaves from unsprayed plots had 2·9% of the area covered with leaf spot, plants sprayed three times with benomyl or fentin

https://doi.org/10.23637/ERADOC-1-124

hydroxide at 0·6 lb a.i./acre had only 0·3%. At harvest 16% of stalks in the unsprayed plots had foot rot and 22% in plots with three benomyl sprays, but only 4% in plots with three fentin hydroxide sprays. Three fentin hydroxide sprays increased seed yield by 14% and three benomyl sprays by 4%.

At Pointon and Swaton near Sleaford, Lincolnshire, in two seed crops grown-on *in situ* from stecklings raised under cereal cover, plants were sprayed with fentin hydroxide at 0·6 lb a.i./acre between 29 April and 28 May. On 22/23 July mid-stem leaves from unsprayed plants and those sprayed once, twice or thrice had 2·8%, 2·3%, 1·2% and 1·6% leaf spot respectively at Pointon, and 9·0%, 2·9%, 1·4% and 1·3% at Swaton. At Pointon two sprays increased seed yield by 7% and three sprays by 8%. At Swaton plant samples were taken from discard rows of the control plots 2 weeks before harvest; this caused seed to shed, which is thought to account for the large apparent effect of a 25% increased seed yield from spraying. (Byford and Harding)

Docking disorder

The spring was unusually wet and more than 19 000 acres of sugar beet were affected by Docking disorder by the end of June, considerably more than in any previous year. The factory areas most affected were King's Lynn (4240 acres), Nottingham (2830), York (2280), Bury St. Edmunds (1832), Selby (1750), Ipswich (1500), Newark (1180) and Wissington (1015).

Survey. Samples of soil from 60 sugar-beet fields where Docking disorder was expected were taken and examined for eelworm; 37 of the fields showed Docking disorder early in the year, but the crop on nearly half of them seemed to recover during the summer. *Trichodorus* spp. occurred in 46 of the fields and *Longidorus* spp. in 36, but there was very little correlation between numbers of either and final root weight; this is partly because different sampling procedures were used in different areas and nematodes in some samples were damaged before reaching Broom's Barn. The survey confirms that a count of nematodes does not reliably predict where the disease will occur. In contrast, of the five fields included in the survey where Docking disorder was not expected, none had any *Trichodorus* or *Longidorus* and none produced crops with Docking disorder. (Cooke)

Viruses. Stunted beet from 51 of the fields surveyed for Docking disorder were tested for soil-borne viruses during late July or early August. Samples from 21 sites included plants with 'yellow blotch' symptoms; inoculating sap from the roots to test plants confirmed that 11 had tobacco rattle virus, but this was not transmitted from the other ten. Plants from one site were infected with tobacco rattle and tomato black ring virus. (Heathcote)

Herringswell Rotation Experiment. This experiment (*Rothamsted Report for 1968*, Part 1, 277) was intended to end with the sugar-beet crop taken in

https://doi.org/10.23637/ERADOC-1-124

1968. However, the barley grown on the site with uniform manuring in 1969 was so obviously different on different plots that yields were measured. Neither previous cropping, nor nitrogen fertiliser applied for previous crops affected yield, but as Table 3 shows, this was greatly increased by fumigating the soil with 'D-D' mixture. The beneficial effects are lasting, for although the largest increase was from the most recent fumigation, fumigation three years previously increased grain yield by more than 6 cwt/acre in one of the two series. On soils of this type, when yields of sugar beet can be miserable when the year favours Docking disorder, fumigation not only avoids risks of losses from this cause, but also produces substantial benefits to other crops grown in rotation with sugar beet. (Cooke and Hull)

TABLE 3

Effect of fumigation with 'D-D' on yield of barley (at 85% dry matter) at Herringswell in 1969

When fumigated	Yield of barley (cwt/acre) (comparable within columns) Rotations 2–5	Rotations 1 & 6–12
Never	34·5	28·9
1966	37·9	35·6
1967	38·1	—
1966 and 1967	39·1	—
1968	—	40·1
1966 and 1968	—	40·4
Mean	37·4	36·2

Nematicide trials. Aldicarb ('Temik' 10 GV) granules were drilled in the furrow with the seed, at 4·4, 8·2 and 18 oz a.i./acre at three sites in East Anglia, and at 5·8, 11·0 and 24 oz a.i./acre at two sites in Yorkshire and one in East Anglia. The sites, numbers of *Longidorus* and *Trichodorus*/litre of soil at drilling, and drilling dates, were: in East Anglia, Hockwold—20, 0, 18 April; Holt—0, 1800, 14 April; Leiston—15, 50, 16 April; Cockley Cley—0, 450, 4 April; in Yorkshire, Holme on Spalding Moor—0, 200, 9 April, and Raskelf—0, 1500, 10 April. All the soils are sandy except at Hockwold which is peat fen on sand; pH of the seedbed was between 7·2 and 8 at the East Anglian sites, but 6·3 in Yorkshire. Monogerm seed was drilled at 3–4 in. spacing except at Cockley Cley where multigerm seed was sown at 2 in. spacing. Rain was more than average in April and May and Docking disorder developed at some sites, especially in Yorkshire. Seedling and post-singling plant populations were rather variable but usually slightly smaller with aldicarb, especially the larger amounts, than without it. On average the small (4·4 and 5·8), the medium (8·2 and 11·0) and the large (17·7 and 23·6 oz) amounts decreased seedling populations by 4·1, 4·0 and 8·2% and plant populations by 2·5, 3·2 and 4·1% respectively. Plant vigour was usually improved, especially during early summer, but not later, and most in Yorkshire. Vigour tended to increase with increasing amounts of aldicarb, except that it was less with 24 oz than with 11 oz in two of the trials. Yield was increased most in Yorkshire;

https://doi.org/10.23637/ERADOC-1-124

on average by 34, 38 and 40% with 5·8, 11·0 and 24 oz aldicarb/acre. At 0, 5·8, 11·0 and 24 oz a.i./acre sugar yields (cwt/acre) were 45·8, 53·9*, 56·0** and 58·0** at Holme and 32·9, 49·3**, 50·7** and 50·6** at Raskelf. In East Anglia effects were less or nil; with 0, 4·4, 8·2 and 17·7 oz a.i./acre sugar yields were 40·3, 43·1, 44·7* and 45·3* at Hockwold; 58·1, 59·8, 60·1 and 64·0 at Holt, and 39·6, 39·7, 39·0 and 37·3 at Leiston. At harvest the roots were scored for fanginess on a scale 0 = perfect, 5 = very fangy. Root shape was greatly improved in the two Yorkshire trials; at Holme Moor from 2·4 to 1·0, 1·4 and 1·5 and at Raskelf from 3·7 to 1·1**, 0·7*** and 1·0***, by 5·8, 11·0 and 24 oz a.i./acre. Without aldicarb root shape was much better in the East Anglian trials than in Yorkshire, but was improved from 1·5 to 1·1**, 1·2* and 1·1** at Hockwold and from 1·0 to 0·6**, 0·6* and 0·6** at Holt, by 4·4, 8·2 and 17·7 oz a.i./acre. At Leiston, where root shape was very good, fanginess was slightly increased from 0·5 to 0·6*, 0·7* and 0·8**. (*, **, *** = Significant at 5%, 1% and 0·1% respectively.)

Several nematicides were tested at Holt and Mansfield, as liquids or granules in the furrow with the seed in single-row plots with untreated rows between. 'Boots RD 8502', 'Ciba C 14421', diazinon, methomyl, 'Neosar', 'Plant Protection JF 2614' and 'Geigy GS 13006' were used at 4 and 32 oz a.i./acre in solution or suspension applied at 16 gal/acre; none increased yield significantly at either site. Diazinon (32 oz a.i./acre) damaged the beet at both sites, greatly decreasing plant population, vigour and yield. 'GS 13006' and 'Neosar' at 32 oz a.i./acre gave smaller plant populations at both sites and less yield at Holt. In contrast to these substances, aldicarb granules at 8 oz a.i./acre increased root yield from 4·2 to 12·3*** ton/acre at Mansfield and from 16·5 to 21·6* ton/acre at Holt.

Methomyl and thionazin, which often damage plants, were tested on the sandy soil infested with *Longidorus* at Herringswell and on a clay loam free from Docking disorder at Broom's Barn. They were applied at 6 and 24 oz a.i./acre, as granules, and as solutions in the furrow with the seed at 16 and 71 gal/acre, and compared with aldicarb granules at 9 and 36 oz a.i./acre, which increased yield at Herringswell from 50·1 to 64·4** and 65·9** cwt sugar/acre. Methomyl and thionazin decreased seedling and plant numbers in both trials, especially with 24 oz a.i./acre at Herringswell. Methomyl at 6 oz a.i./acre increased yield by 7·5 cwt sugar/acre at Herringswell where Docking disorder occurred, but decreased it at Broom's Barn, which the smaller amount of thionazin did at both sites. At Herringswell both methomyl and thionazin at 24 oz a.i./acre, as either granules or solutions at 16 and 71 gal/acre, decreased yields, methomyl from 50·1 to 38·6*, 39·1* and 45·7 and thionazin to 13·6**, 34·0** and 49·9 cwt sugar/acre. At 71 gal/acre both materials were less harmful than at 16 gal/acre but this difference was less evident at Broom's Barn where the soil is heavier and the plants were less damaged.

'Filcoat' pelleted Amono seed incorporating 'Dexon' (0·33% a.i. by weight of unpelleted seed), methomyl (2 and 0·5% a.i.), isobutyridene diurea, (0·5, 6 and 30% N), superphosphate (0·5, 2 and 4% P) and 'Ciba C 14421' (0·25, 1 and 4% a.i.) was tested at Hilborough, Holt and Leiston.

https://doi.org/10.23637/ERADOC-1-124

No treatment was consistently harmful or beneficial to plant population, plant vigour or yield.

Since 1964 various formulations of 29 nematicides have been tested for the control of Docking disorder when applied with the seed during drilling. Menazon, methomyl, phorate and thionazin have sometimes been effective, but aldicarb has invariably greatly improved vigour and yield where Docking disorder was severe. From 1967 to 1969 it has been tested 19 times on sandy soils and twice on peat soils where Docking disorder was expected; Docking disorder occurred at the two sites used in 1967 (single-row plots only), 3 of 10 of those in 1968, and 7 of 9 in 1969. Averaging the results in 1968 and 1969, 4, 8 and 16 oz a.i./acre (interpolating between other amounts where necessary) increased yield by 8, 10·5 and 12·4% respectively (48·9 cwt sugar/acre increased by 3·4, 4·3 and 5·5 cwt). Aldicarb is to be marketed on a limited scale for the control of Docking disorder in 1970; at the expected cost its use will be justified only on the more responsive sites. Row treatment with 'D-D' or 'Telone' 2 weeks before sowing will probably increase yield more, especially where nitrogen is needed in the root zone. (Dunning and Winder)

Row fumigation. The effect of fumigating only the bands of soil into which the beet were to be drilled was tested at four sites where Docking disorder was expected and one, at Broom's Barn, where it was not. Different amounts of 'D-D' and 'Telone' were injected 8 in. deep by tines drawn through the soil 2 weeks before sowing or immediately before sowing; other treatments were three amounts of aldicarb applied with the seed in the row and two amounts of N fertiliser as a top dressing.

At two of the sites *Trichodorus* and *Longidorus* were counted at different depths and distances from the line where 'D-D' was injected at 1 ml/ft of row. This dose of 'D-D' killed 84% of the *Trichodorus* and 91% of *Longidorus* in the treated line within 4–5 weeks, but had no effect on nematode numbers 10 in. from the treated line (Tables 4 and 5).

TABLE 4

Numbers of L. elongatus*/litre of soil at Mansfield, Notts.*

	4 weeks after treatment			14 weeks after treatment		
Depth	Distance from line of injecting 'D-D'					
(inches)	0 in.	5 in.	10 in.	0 in.	5 in.	10 in.
0–3	15	68	102	40	50	40
3–6	15	23	152	23	80	107
6–9	—	23	98	7	47	62
Mean	10	38	117	23	59	70

Nos. in untreated plots: 115/litre 4 weeks after treatment
87/litre 14 weeks after treatment.

Estimates were also made of the effect of the three amounts of 'D-D' and 'Telone' applied on the 8 and 9 April on nematodes in the lines of injection. At the first sampling date, the effect of ½ ml/ft was very variable

https://doi.org/10.23637/ERADOC-1-124

TABLE 5

Numbers of T. cylindricus/*litre of soil at Hellesdon, Norfolk*

	5 weeks after treatment			14 weeks after treatment		
Depth	Distance from line of injecting 'D-D'					
(inches)	0 in.	5 in.	10 in.	0 in.	5 in.	10 in.
0–3	365	465	1085	200	333	483
3–6	200	2415	3385	283	1033	1600
6–9	350	1300	2080	83	685	817
Mean	305	1395	2185	189	683	967

Untreated plots: 1865/litre 5 weeks after treatment
883/litre 14 weeks after treatment.

TABLE 6

Longidorus elongatus *at Mansfield, Notts.*

	Intended dose ml/ft row	Actual dose ml/ft row	*L. elongatus* 4 weeks after treatment (% of control)	*L. elongatus* 14 weeks after treatment (% of control)
'D-D'	0·5	0·51	20	46
	1·0	1·00	9	27
	2·0	1·73	0	2
'Telone'	0·5	0·58	59	19
	1·0	1·01	19	19
	2·0	1·71	0	0

TABLE 7

Trichodorus cylindricus *at Hellesdon, Norfolk*

	Intended dose ml/ft row	Actual dose ml/ft row	*T. cylindricus* 4 weeks after treatment (% of control)	*T. cylindricus* 14 weeks after treatment (% of control)
'D-D'	0·5	0·51	82	26
	1·0	0·86	16	21
	2·0	1·81	13	15
'Telone'	0·5	0·44	43	42
	1·0	0·96	13	11
	2·0	1·58	13	19

but 1 ml/ft always killed at least 80% of the *Trichodorus* and *Longidorus* (Tables 6 and 7).

Neither of the fumigants applied 2 weeks before sowing had any effect on plant population, but the large dose applied immediately before sowing sometimes considerably decreased emergence and final plant population. The most serious effect was at Mansfield, Notts., where much rain fell immediately after injecting the fumigant; here seedling emergence was halved by 1 ml/ft 'D-D' or 'Telone' immediately before sowing, and with 2 ml/ft of 'Telone' immediately before sowing only 6% of the seedlings emerged. At other sites the effect on plant population was less serious and had largely disappeared after singling. Any small effects on emergence and plant stand of the treatments were more than compensated by better growth and sugar yield from 4 to 8 cwt/acre more than the 50 cwt/acre

https://doi.org/10.23637/ERADOC-1-124

from the untreated crop. Only 2 ml/ft of 'Telone' applied at drilling failed, on average, to increase yield. 'Telone' was most effective when applied 2 weeks before sowing at 1 ml/ft and 'D-D' when applied 2 weeks before sowing at 2 ml/ft. Aldicarb also increased yield significantly but less than the fumigants, possibly because, unlike them, it does not increase the amount of mineral N in the soil early in the season. The two N top dressing treatments applied early in June did not significantly affect yield. (Cooke, Dunning and Winder)

Nitrogen and fumigation. The effects of fumigating all the top soil and of N fertiliser on nematode numbers, root shape and sugar yield, were studied again in five factory areas (*Rothamsted Report for 1968*, Part 1, 279)

Soil sampling showed that *Trichodorus* was more abundant in the deeper soil than in the drier surface layer during April. Soil fumigation in December brought the population in April to less than 5% of that in unfumigated plots; these survivors increased only slowly throughout the year (Table 8). Populations of other plant-parasitic nematodes were similarly diminished but the rhabditids, which are mostly saprophytic, seemed able to increase again faster than the parasites after fumigation (Table 9).

TABLE 8

Average number of Trichodorus/*litre of soil from five experiments*

Depth (inches)	April		August*	
	Unfumigated	Fumigated	Unfumigated	Fumigated
0–2	167	25	1219	69
2–4	970	28	1694	163
4–6	1362	38	1309	138
6–8	1223	43	1122	141

Soil fumigated with 33·5 gal 'D-D'/acre

* Average of four experiments only

TABLE 9

Average numbers of nematodes/litre of soil from five experiments

	April		August*	
	Unfumigated	Fumigated	Unfumigated	Fumigated
Tylenchus	210	11	165	24
Pratylenchus	446	33	414	50
Tylenchorhynchus	2400	97	1174	62
Rhabditis	2551	2148	1684	1133

Soil fumigated with 33·5 gal 'D-D'/acre

* Average of four experiments only

Fumigation greatly increased plant vigour throughout the season at four of the five sites and improved root shape, which was also improved at some sites by increasing N. Much nitrogen was leached from the soil during the wet spring and on the unfumigated plots, where the roots of the plants were damaged by nematodes, sugar yield was increased by even the

21

https://doi.org/10.23637/ERADOC-1-124

largest dressing of N (Table 10). On the fumigated plots 1·32 cwt/acre N gave the most sugar; sugar yields on the fumigated plots were much greater than on the unfumigated ones with all N dressings. (Cooke and Draycott)

TABLE 10

Mean effect of N and fumigation with 'D-D' on sugar yield at five sites

Nitrogen dressing (cwt/acre)	0	0·66	1·32	1·98
	Sugar yield (cwt/acre)			
Not fumigated	32·8	36·7	36·8	38·8
Fumigated	45·8	50·5	53·0	51·0

Cyst eelworm

Aldicarb was tested on two sites infested with *Heterodera schachtii* (cf. *Rothamsted Report for 1968*, Part 1, 282). At Lakenheath the field was first found infested in 1964 and the sugar beet crop was grown under licence after 4 years without host crops. The soil was a sandy chalk with 24 eggs/g, and 15 *Longidorus* and no *Trichodorus*/litre of soil. At Burwell Fen, where the crop had been stunted by cyst eelworm in 1968, 1 acre was again cropped with beet under licence. The soil was a peat/chalky clay mixture containing 23 eggs/g.

At Lakenheath, aldicarb (10 G) granules at 55 oz a.i./acre decreased plant population and plant vigour early in the season, but smaller amounts increased vigour. Although white cysts were readily found on the roots during the summer and autumn, the eelworms apparently did little harm to the crop. Beet sickness did not develop, root shape was good at harvest and the sugar yield of 44 cwt/acre on the control was not affected by aldicarb. At Burwell, aldicarb (10 GV) granules at 8, 15, 31 and 70 oz a.i./acre in the row with the seed did not affect seedling numbers but at 70 oz increased plant population from 22 000 to 32 000/acre. Plant vigour was greatly improved, especially by the smaller doses early in the season and the larger ones later. At harvest root fanginess was halved and sugar yield increased from 25·7 to 30·8, 29·7, 36·5* and 34·7 cwt/acre by the increasing doses. (Dunning and Winder)

Seed production

Seed from experiments at Stonesfield, Oxon, and at Sutton St. Edmunds, Lincs., testing how cultural practices affect seed yield, was harvested and cleaned as in 1968 (*Rothamsted Report for 1968*, Part 1, 283). Seed from similar experiments harvested in 1968 was tested for germination in the laboratory and for seedling emergence both from compost in the glass-house and soil in the field. Efforts were made to improve the performance of the bulk by grading, seed advancement and washing. The effect of storage conditions on quality is also being studied. Work is now exclusively on genetical monogerm varieties.

https://doi.org/10.23637/ERADOC-1-124

Factors affecting seed yield

Time of sowing and harvesting. Plots sown at Stonesfield, Oxon., on 5 July and 5 August 1968 respectively gave yields of 3956 and 3420 kg/ha ($\pm$138·3) of seed. This difference is less likely to be attributable to differences between plant populations (382 and 311 ($\pm$7·2) thousands/ha) given by the two sowings than to the effect of sowing date on plant growth. The yield on 21 August or 2 September was significantly greater than on 11 September. The greatest yield (4425 kg/ha) was from plants harvested on 2 September from sowing on 5 July.

Fertilisers. The effects of 12 different combinations of fertilisers applied to the seed bed before sowing, or to the crop next spring, were assessed on a seed crop grown in limestone soil at Stonesfield, Oxon. All plots received a basal dressing of 98 kg/ha N, 98 kg/ha P_2O_5: and 150 kg/ha K_2O. Plot treatments supplied 125 kg/ha K_2O in the seedbed before sowing, 188 kg/ha P_2O_5 and 125, 188 or 250 kg/ha N top dressed the following spring. There were small, non-significant increases in yield of seed from the K_2O and P_2O_5, and the yields of cleaned seed for plots given 125, 188 or 250 kg/ha N were 3661, 4009 and 4075 kg/ha ($\pm$107·9) respectively.

The effects of eight different combinations of N and P_2O_5 fertilisers applied as top dressings in the autumn of the following spring were tested on a seed crop grown under barley in deep fertile soil at Sutton St. Edmunds, Lincs. After removing the barley, all plots received 88 kg/ha N and 250 kg/ha K_2O. Plot treatments supplied 94 or 188 kg/ha P_2O_5 in the autumn and 125 kg/ha P_2O_5 with 188, 250 or 312 kg/ha N in the spring. Extra P_2O_5 either in the autumn or in the spring increased seed yield but the increases were small and not significant. Similarly, the yield of seed from plots given 188, 250 or 312 kg/ha N increased from 5508 to 5614 and 5730 kg/ha but the differences were not significant (s.e. $\pm$159).

Plant population. Sugar beet sown at Stonesfield, Oxon, on 5 July 1968 in rows 10 or 20 in. apart were thinned to approximately 2, 6 or 12 in. apart within the rows. When harvested on 3 September 1969 the greatest yield of seed (4415 kg/ha) came from the densest plant stand (10 $\times$ 2 in.), but this was not significantly more than at 10 in. $\times$ 6 in. spacing (4054 kg/ha seed $\pm$16·8). Other treatment combinations gave smaller yields. These results agreed with those obtained in the contrasting weather of 1968 and showed that, on the Cotswold limestone soils, an optimum plant population for seed yield with an optimum dressing of fertiliser but without irrigation is between 200 and 250 thousand/ha. A nearly square plant arrangement would probably yield more seed at a given population than a rectangular pattern.

Harvest method. In March 1969 stecklings were transplanted into the field at Broom's Barn. There were two replicates of two varieties and two harvest dates, each harvested by four methods: 'barn dried' plants were cut, placed in loose-weave, hessian bags and unheated air blown through them for 10 days or more until they were ready for threshing; 'desiccated'

https://doi.org/10.23637/ERADOC-1-124

plants were sprayed with diquat at 770 g ion/ha and cut 7 days later for threshing; 'swathed' plants were cut about 25 cm from the ground and the seed-bearing stems laid on the stubble until dry enough to thresh; 'tripodded' plants were cut, laid on wooden tripod frames outdoors and left until dry enough to thresh. Harvesting on different dates, 27 August and 5 September, did not affect seed yield, nor did variety. The plots were netted to exclude birds. The yields of seed from barn dried, desiccated, swathed and tripodded plants were 3534, 3507, 3060 and 3411 kg/ha ($\pm$182) respectively. Shattering accounted for the smaller yield (though not significantly) from swathed plants.

Pollen. Pollen liberation from small plots of diploid and tetraploid sugar beet transplanted during March 1969 was followed with spore traps operated from 1 July to 1 August 1969. Again less tetraploid pollen was released than diploid; tetraploid was first trapped later in the day and reached a daily peak about 1 hour later. Male sterile plants that had first received different manurial and defoliation treatments were exposed to the pollen cloud. Defoliation by scissors at flowering halved the yield of cleaned seed. Manures at flowering did not affect yield of seed set by defoliated or unpruned plants. Manures at planting were most important and increased yield/plant from 2·5 to 12·7 g seed on defoliated plants, and from 4·2 to 26·3 g on unpruned plants. Within a treatment, yields of seed from individual plants differed by a factor ranging from 2·5 to 49, suggesting that seed yield might respond dramatically to selection.

Factors affecting seed performance

Time of sowing and harvesting the seed crop. EMP steeped, dieldrin-dressed seed from plots drilled on 29 June, 19 July and 18 August 1967 and harvested on 5, 12 and 19 September 1968 was sown in the field on 9 and 10 April. Emergence of seedlings was not significantly affected by time of sowing or harvesting the seed crop, but late-harvested seed tended to give more seedlings than seed harvested early. Seedling shoot dry weight 8 weeks after sowing was not affected by seed harvesting date.

Seed crop fertilisers. EMP steeped, dieldrin-dressed, seed from fertiliser experiments harvested on 27 and 28 August 1968 was sown in the field on 13 April. Fertilisers applied to the seed crop affected neither seedling emergence nor shoot dry weight 7 weeks after sowing, but seed from the plots given phosphate fertiliser in the second year of growth gave slightly heavier seedlings. Chemical analysis of the seeds showed no differences in phosphate concentration, which averaged 0·47% dry weight basis. Per cent N in the seed increased from 2·04 to 2·25 with increase in fertiliser from 188 to 312 kg/ha N applied to the seed crop.

Seed crop plant population. EMP steeped, dieldrin-dressed, seed from crops grown at 8 different plant populations and harvested on 12 September 1968 was sown in the field on 13 April, but no effects of seed crop plant population were detected on seedling emergence or shoot dry weight 7 weeks after sowing.

https://doi.org/10.23637/ERADOC-1-124

Seed size. Seed harvested on 23 August, 31 August and 6 September 1966; 14 August, 24 August and 7 September 1967, and 5, 12 and 19 September 1968, were sorted into grades 7–8, 8–9, 9–10, 10–11 and 11–12/64 in. diameter. EMP steeped, dieldrin-dressed, samples were sown in the field on 13 April. The final emergence (seedlings per 100 seeds sown) from the five diameter grades were 33, 51, 63, 72 and 90 ($\pm$1·30) respectively. The mean emergence from early, middle or late seed crop harvest dates were 59, 66 and 68 ($\pm$1·13). The mean seedling emergences from seed harvested in 1966, 1967 and 1968 were 74, 54 and 64 ($\pm$0·83). Although not affected by year or date of harvest, the seedling shoot dry weights 8 weeks after sowing were 249, 260, 270, 281 and 267 mg ($\pm$9·41) respectively with increasing seed diameter.

Seed advancement. The technique for carrot seed advancement (Austin, Longden & Hutchinson, *Ann. Bot.* (1969), **33**, 883–895) was modified for sugar beet seeds. Three cycles of 24 hours imbibition with 150% by weight of water followed by 48 hours re-drying at room temperature did not affect final emergence but shortened the time to 50% emergence from 7·6 to 5·1 days ($\pm$0·15) and increased seedling shoot fresh weight from 27·4 to 39·5 mg ($\pm$1·35). In a second experiment, four cycles in each of which 100% by weight of water was added shortened the time to 50% emergence from 9·7 to 7·5 days ($\pm$0·42) and increased seedling shoot fresh weight from 62·0 to 95·2 mg ($\pm$5·28). Treatments involving fewer but longer cycles were less successful. In a third experiment, rubbed seed of two varieties was given five cycles of advancing in each of which 100% by weight of water was added. Both varieties responded to the treatment and the fact that growth rates of seedling shoots between 14 on 23 days after sowing were similar suggested that the heavier shoot weight reflected a quicker emergence. Radiographs and conventional sectioning of seeds failed to show any structural changes resulting from advancement. However, re-rubbing treated seeds caused 39% to lose their lids, whereas only 9% of the untreated seeds did, and much of the beneficial effect of advancement of sugar beet seeds may derive from loosening the lids, which facilitates germination.

Seed washing. Sugar-beet seed is washed as a routine for germination tests in the laboratory, to remove germination inhibitors. Seed sown in the field is not usually washed but is steeped in ethyl mercury phosphate solution to control seed-borne fungi. In our first experiment, unrubbed seed of three varieties had a mean seedling emergence from compost that increased from 52 (unwashed) to 64% after washing in tap water at 25°C for 3 hours and re-drying overnight on filter paper at room temperature. Further washing up to 24 hours had no additional effect. In a second experiment, 20 samples of commercial rubbed seed representing different batches and varieties, were washed in tap water at 25°C for 3·5 hours and dried overnight in filter paper at room temperature. Washing increased the percentage emergence when sown in compost from 83 to 88; for eight samples the increase was between 7 and 11% all significant effects. Variety did not affect emergence. Mean seedling shoot weight was increased from

https://doi.org/10.23637/ERADOC-1-124

93 to 103 mg ($\pm$ 1·4) by washing, but although washing the seeds of 19 of the 20 seed lots gave larger shoot weights, the effect was significant for only two. Seedling shoot weight was also affected by variety and was well correlated with seed weight.

Storage. After harvest in September 1968, rubbed and raw seed of two varieties were equilibrated to 8, 12 and 18% moisture content and small samples sealed in glass test tubes, which were incubated at 2, 10 and 22°C. In June 1969 tubes representative of all treatment combinations were opened and the seed sown in compost. Rubbed and raw seed of both varieties reacted in the same way to storage moisture and temperature. Seed stored at 10°C gave more seedlings and seedling shoot fresh weight than seed stored at 22°C, but storing at 2°C gave no further benefit. Storage at 12% moisture content was better than at 18%, and there was a further small, but still significant benefit, by storing at 8%.

Soil condition. The effects of incorporating different conditioners in the soil on seedling emergence and growth were assessed on plots at Saxmundham (*Rothamsted Report for 1966*, 38). A first sowing on 8 April was made when the seedbed was warm and moist but fine and workable. None of the treatments affected seedling emergence (mean, 75%) or shoot dry weight on 13 May. A second sowing was made on 23 May into a very sticky, wet seedbed. Emergence on the plots treated with peat was less (55%) than on the untreated plots (72%) and although other soil conditioners had no significant effect, all except krilium gave fewer seedlings. Seedling shoot weight on 17 June was less on plots treated with coarse Lytag than on others, but root or shoot fresh weight or sugar yield on 8 October were not affected. All the soil conditioners tended to increase the proportion of fangy roots. (Longden)

Sugar beet manuring

The experiments reported below dealing with peat remnant, magnesium, nitrogen and liming materials were done in co-operation with the British Sugar Corporation in 1968.

N P K Na on peat remnant. Four experiments were made on Fenland fields where the peat layer had become so thin that the plough penetrated the clay subsoil; 1968 was the third year of these experiments. N was applied at 0, 0·6 and 1·2 cwt/acre; P_2O_5 at 0, 0·75 and 1·5 cwt/acre; K_2O at 0, 1·0 and 2·0 cwt/acre; NaCl at 0 and 3·0 cwt/acre. The four nutrients were applied to plots in a factorial design.

The results mostly confirmed previous ones. Nitrogen increased the yield of roots by 1 ton/acre on average but decreased sugar content, resulting in only a marginal increase in sugar yield. Potash consistently decreased and sodium slightly increased yield of roots and sugar; neither affected sugar content.

Phosphate gave the largest increase in root yield without affecting sugar

https://doi.org/10.23637/ERADOC-1-124

content. All fields responded and the largest dressing tested (1·5 cwt/acre) was always justified.

Magnesium. The object of four experiments of a new design was to compare kieserite and calcined magnesite as magnesium fertilisers for sugar beet, to investigate response to magnesium in areas where magnesium fertilisers have not been tested before, and to provide material for magnesium uptake studies described below. Fields were chosen where deficiency symptoms were expected to develop on the sugar-beet leaves and, where there was more than one suitable site, that with the smallest content of exchangeable soil magnesium was used.

The treatments tested were 0, $1\frac{1}{2}$ and 3 cwt/acre calcined magnesite; $2\frac{1}{2}$ and 5 cwt/acre kieserite. 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. There was little response to magnesium on average, but kieserite seemed to be slightly more effective than calcined magnesite, both in correcting leaf symptoms and increasing yield.

Long-term effects of magnesium. Two experiments begun in 1964 were cropped with sugar beet for the second time in 1968; their design was described in *Rothamsted Report for 1966*, 292. The sugar beet responded to the magnesium, and the kieserite at 5 cwt/acre applied 5 years before gave the largest yield of roots and sugar. FYM and kieserite at 5 cwt/acre applied 1 year before the sugar beet gave the same yield. Kieserite applied previously was consistently better than recently applied kieserite, presumably because it was better distributed in the soil. Magnesium limestone applied 5 years previously also gave a large response, and kainit a smaller one. The indication from these experiments is that magnesium fertilisers have a large residual effect, with benefits lasting for at least 5 years and probably longer.

Three other experiments of the same design begun in 1967 were cropped with sugar beet for the first time in 1968. There was a response on average to the magnesium but too small to compare forms and times of application. The plots will be cropped with sugar beet again in 1971.

Nitrogen and soil type. New experiments were begun to examine in greater detail than previously the relationship between the amount of nitrogen fertiliser given for sugar beet and yield. Fields were adequately manured with phosphate, potash and salt and eight equal increments of nitrogen were tested ranging from 0 to 2·31 cwt/acre N as 'Nitro-Chalk'. Five experiments were made on soils with a sandy texture, three on shallow, calcareous soils and three on deep, heavy clays. Sugar beet grown on the sands gave most return in yield from nitrogen and least on the calcareous soils. However, sugar beet on all three soil types needed about the same amount (1·0 cwt/acre N) of fertiliser nitrogen for maximum sugar yield.

Long-term effects of liming. Five experiments were started to follow the changes in soil pH and effects on yields of sugar beet of liming slightly acid soils. Ground limestone was tested at $2\frac{1}{2}$ and 5 tons/acre and waste

https://doi.org/10.23637/ERADOC-1-124

lime from sugar beet factories at 5 and 10 tons/acre. The yields of all plots at each site were similar when cropped with sugar beet in 1968. When the fields are cropped with sugar beet again in 1971, the plots will be subdivided and further lime dressings applied. In the intervening years soil pH will be measured periodically. (Draycott)

Plant nutrients

Sodium, magnesium and irrigation. The experiment on Brome Pin field (*Rothamsted Report for 1968*, Part 1, 288) was repeated on Marl Pit field. Samples of soil and sugar beet were taken from each plot at monthly intervals from May until November. Yield, leaf area, uptake of magnesium and sodium and depletion of soil magnesium were measured. The summer was relatively dry and irrigation was needed in June, July and August to prevent the soil moisture deficit from exceeding 1·5 in.

Throughout the growing season magnesium had no effect on yield but sodium increased yield of both tops and roots, as did irrigation. In August irrigation increased yield of tops by 5 tons/acre. Sodium and irrigation also increased the dry matter yield of both tops and roots during the latter part of the season. The leaf area index (L.A.I.) of the crop reached a maximum at mid-August. Sodium increased L.A.I. early in the season and irrigation did from July onwards. The leaves wilted several times during July and August, and observations made at the time failed to confirm the idea that sodium fertilisers help to prevent wilting.

The sodium and magnesium increased sugar percentage, and irrigation decreased it slightly. There were no significant interactions between any of the three factors in sugar yield at the final harvest. Sodium with irrigation increased sugar yield by 8 cwt/acre, about half of which was attributable to sodium and half to irrigation. (Draycott and Farley)

Magnesium uptake. As in two previous years (*Rothamsted Report for 1967*, 286 and *for 1968*, 288) plants and soil were sampled at monthly intervals from four experiments measuring the response of sugar beet to 5 cwt/acre kieserite. Table 11 shows the yields at Cantley, the most responsive field in 1969 where 60% of the plants had symptoms of magnesium deficiency in October. The kieserite increased yield of tops from July onwards, probably by preventing premature death of the leaves. This was followed by large increases in root yields in the autumn.

TABLE 11

Yield of sugar-beet tops and roots (tons/acre) in response to kieserite at Cantley in 1969

	Without kieserite		Response to kieserite	
Sampling date	Tops	Roots	Tops	Roots
8 June	0·6	0·1	0·0	0·0
3 July	5·3	1·0	+0·1	+0·1
5 August	15·9	8·1	+1·9	+0·1
15 September	17·3	16·3	+1·3	+0·3
14 October	16·6	18·2	+2·6	+2·2
20 November	11·8	19·3	+0·8	+2·2

https://doi.org/10.23637/ERADOC-1-124

During 1969 soils from 60 other experiments with magnesium fertilisers made between 1959 and 1968, were analysed for exchangeable magnesium. Extractant solutions of ammonium acetate, ammonium nitrate and calcium chloride were compared. The relationships between soil magnesium and response to magnesium fertiliser showed that all extractants detected most fields where sugar beet gave a large response to magnesium and those where there was no response. Small responses were difficult to predict and no extractant was reliable. (Draycott and Durrant)

Manganese. Two experiments on fields at Ely and Peterborough, selected as likely to produce manganese-deficient sugar beet, tested response to two and four sprays of manganese sulphate (equivalent to 8 and 16 lb/acre elemental manganese), two similar amounts of manganese fertiliser in the form of glassy 'frits' and manganese oxide at 8 lb/acre Mn. At Ely the soil contained 1 ppm water soluble, 6 ppm exchangeable, 53 ppm easily-reducible and 24 ppm 'available' (extracted in ammonium dihydrogen phosphate solution) manganese. The Peterborough soil contained 1 ppm water soluble, 1 ppm exchangeable, 100 ppm easily-reducible and 19 ppm 'available' manganese.

Symptoms of manganese deficiency were most severe in June when at Ely 40% of the plants not given manganese had symptoms, whereas only 5% had symptoms at Peterborough. All the manganese treatments decreased the percentage of plants with symptoms but none eliminated them. All the manganese treatments increased the manganese concentration in the plants. At Ely, 16 lb/acre Mn either as spray or fertiliser increased yield by 2·2 cwt/acre sugar but at Peterborough none of the treatments affected yield.

Similar manganese treatments were tested in an experiment using soils from Ely and Peterborough in pots, where a range of soil pH was obtained by adding lime. None of the sugar beet plants had symptoms and, although the manganese treatments increased the manganese concentration in the plants, none increased yield. (Draycott and Farley)

Nitrogen requirement. The work begun in 1968 (*Rothamsted Report for 1968*, Part 1, 289) on the nitrogen requirement of sugar beet continued on similar fields in the same factory areas. Top soil and subsoil from each site was sampled on three occasions during the winter of 1968–69 and incubated aerobically and anaerobically. The calcareous loam invariably contained most mineral-N when sampled during the winter and also released most when incubated either aerobically or anaerobically. The subsoil also contained an appreciable concentration of mineral-N through the winter, although on average the clay subsoil at Nottingham produced as much mineral-N when incubated.

Top soil and subsoil samples were taken each month during the growing season from each trial from plots given 0, 0·99 and 1·98 cwt/acre N as 'Nitro-Chalk' applied in the seedbed. Plants were harvested monthly and analysed for total N and NO_3-N concentration in mature leaves throughout the growing season.

The nitrogen fertiliser leached at different rates through the three

https://doi.org/10.23637/ERADOC-1-124

profiles; about 40 lb/acre N had moved through the profiles of both the sand and clay-loam sites by early June. By comparison, the movement of fertiliser-N through the calcareous soil was small and was not measurable by early July. Even the final soil samples, taken in October, showed distinct differences in mineral-N from the applied fertiliser. Without any applied nitrogen fertiliser, the root yields from the calcareous loam and from the clay-loam were the same—14 tons/acre and there were only small responses to applied N. On the loamy sand the root yield without fertiliser was 9 tons/acre; there was a large response to nitrogen fertiliser and 1·65 cwt/acre was needed for maximum yield (13 tons/acre). (Last)

Soil compaction

Two experiments were made with the same design as before (*Rothamsted Reports for 1967*, 242 and *for 1968*, 289) on Little Lane and Marl Pit fields. Compaction did not affect the seedling population on either field but nitrogen fertiliser significantly decreased it on both. There were fewest roots at harvest from compacted plots on Little Lane but final population was not affected on Marl Pit.

Compaction decreased yield greatly in both fields, and more on the heavier soil of Little Lane; with winter compaction, sugar yield was, on average, less by 15 cwt/acre on Little Lane and by 6 cwt/acre on Marl Pit; with seedbed compaction, induced by excessive spring working, it was less by 7 cwt/acre on Little Lane and by 4 cwt/acre on Marl Pit. Again there was a negative interaction between compaction and nitrogen fertiliser —the more compact the soil the more fertiliser nitrogen was required by the crop for maximum yield. In both experiments in 1969, even given the optimum dressing of nitrogen, sugar yield was much less from the compacted than the uncompacted plots. The best dressing of nitrogen on average was 1·20 cwt/acre and the extra phosphate was beneficial on the heavier soil. (Draycott and Hull)

Plant spacing

Nitrogen, spacing and irrigation. This experiment examined how density of plant stand, nitrogen 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 thousands/acre) and nitrogen treatments (N_0—0, N_1—0·6, N_2—1·2 and N_3—1·8 cwt/acre N) were as before (*Rothamsted Reports for 1966*, 296, *for 1967*, 288 and *for 1968*, Part 1, 291).

The early part of the growing season was wet but irrigation was needed during June, July and August to prevent the calculated soil moisture deficit exceeding 1·5 in. A total of 3·4 in. of water was applied. The autumn was unusually dry and the deficit was still increasing when the crop was harvested. The moisture in the soil to a depth of 4 ft was measured every week using a neutron moderation meter. Deficits obtained from these measurements again agreed well with calculated ones. After leaf cover was complete, the amount of water removed from the soil profile during each period, plus rainfall, was equal to the potential transpiration. This

https://doi.org/10.23637/ERADOC-1-124

suggests that the sugar beet root system can extract moisture from a larger volume of soil than many crops.

Irrigation increased sugar yield on average by 2·2 cwt/acre. The mean yields from the four spacings were: S_1—41·1, S_2—50·8, S_3—53·7 and S_4—54·6 cwt/acre and from the N dressing were: N_0—38·8, N_1—50·5, N_2—55·6 and N_3—55·2 cwt/acre. (Draycott)

Twin rows on ridges. The experiment described in last year's Report (p. 289) was repeated on the clayey soil in Little Lane field. Pairs of rows (twins) of sugar beet 10 in. apart and 20 in. between adjacent rows of the twins were compared with single rows 20 in. apart. The twin rows were sown either on a flat seedbed or on ridges. The experiment was unsatisfactory for two reasons. Firstly because of the wet soil, the ridges could not be made until the spring and had to be rolled to make them flat enough to carry the two rows of beet, which compacted the soil. Secondly, beet seed was grown on the site several years ago and not all the volunteer seedlings from this could be distinguished from the sown crop. The final plant populations on the 10 in. twins on ridges, 10 in. twins on the flat and 20 in. rows on the flat were respectively, 51, 46 and 36 thousands/acre and the sugar yields 71·9, 68·4 and 71·7 cwt/acre. Again the 10 in. twins on ridges yielded most but this year the differences were not significant; they also gave a significantly larger sugar percentage than the other plant distributions, but this may be because the stand was denser; 120 units/acre of N gave the greatest yield with all plant arrangements. (Hull and Webb)

Root studies

The root distribution of sugar beet on Marl Pit field was studied using ^{89}Sr and ^{32}P, in co-operation with Dr. P. Newbould of the Agricultural Research Council's Letcombe Laboratory. Plant densities of 7500 and 55 000 plants/acre were used, with and without irrigation. A solution containing the isotopes was placed in the soil at 6, 12, 18, 24 and 36 in. deep on 2 June. Leaf samples were taken from the treated plants in July, August and September, and the whole plants were harvested at the beginning of October. The activity of the plant samples is being measured at the Letcombe Laboratory.

Work began to compare soil moisture extraction by, and root growth of, sugar beet, barley and potatoes. Moisture extraction was measured with a neutron moderation meter. Roots of all crops extracted moisture down to at least 4 ft and the presence of roots at this depth was confirmed by observations in pits provided with glass panels.

In the glasshouse beet seedlings with the cotyledons expanded were set through holes in an asbestos sheet covering a plastic bin and grown with their roots in a mist of nutrient solution. The nutrient mist, which is produced by compressed air atomisers, condenses and returns to the bottom of the bin to be re-circulated. Seedlings sown at the end of April had their primary roots kept pruned to 5, 10 or 20 cm below the level of the asbestos, or not pruned at all. At first there was no obvious difference in size of top growth, but this changed during sunny weather when the

https://doi.org/10.23637/ERADOC-1-124

plants with severely pruned roots wilted and after this were relatively stunted. When harvested after 45 days the unpruned roots averaged 70 cm long and the plants yielded between three and four times as much dry and fresh weight of roots and tops as the most severely pruned. Yields from plants with the other pruning treatments were intermediate but pruning to 5 cm decreased yield proportionately more than the less severe pruning. The ratio of leaf to root yield was similar for all pruning treatments.

A similar experiment started in October and harvested after 56 days tested the effect of root pruning in mist nutrient solution concentrations of 1 : 100, 1 : 200, 1 : 400 or 1 : 1000. The plants never wilted at this time of year and the effects of root pruning on yield were small; on average, the unpruned plants with roots averaging 62 cm. long gave 1·3 times the yield of dry matter in tops and in roots of those pruned to 5 cm. The plants with 1 : 100 nutrient solution yielded 2·6 times the weight of tops of those with 1 : 1000, but the root weight was only 1·3 times greater. The average lengths of unpruned roots in the decreasing concentrations of nutrients were 50, 61, 66 and 72 cm, so root extension is approximately linearly related to log. nutrient dilution. The plants compensated for the lack of nutrients by growing longer roots.

Sugar beet grown on light sands through which nitrate is leached rapidly may depend for normal growth on this reaction of the tap root to lack of nutrients, so if nematodes destroy the tap root, the laterals which develop are inadequate to compensate for it. (Draycott, Durrant and Hull)

Time of sowing, time of harvesting and nitrogen need

This experiment on different dates of sowing and harvesting (*Rothamsted Report for 1968*, Part 1, 291) was repeated on Little Lane field and gave yields shown in Table 12. Plant population averaged 35 500/acre and ranged from 34·3 to 36·6 thousands/acre on the first and second sowing respectively. Bolters were few and confined to the first sowing. Root yield for 0, 0·6, 1·2 and 1·8 cwt/acre of nitrogen averaged 16·3, 18·2, 18·1 and 18·4 tons/acre at 17·8, 18·0, 17·8 and 17·3% sugar respectively, giving sugar yields of 57·9, 65·2, 64·5 and 63·5 cwt/acre. A dressing of 0·6 cwt/acre of N was enough to give maximum sugar yield, irrespective of sowing date and harvesting date. The decrease in sugar yield that resulted from delaying sowing from March until April was less than from delaying from April until May. Sowing later increased α-amino N which was greatest at the November harvest. It was greatly increased by nitrogen dressings. Potassium in the roots increased with later sowing and decreased with delayed harvesting, but was little affected by nitrogen dressings. Sowing and harvesting date had a similar effect on sodium but nitrogen dressings greatly increased it.

The concentration of nitrate in fresh sugar-beet petioles which is a guide to the nitrogen status of the crop, was measured periodically during the season. Plants were first sampled at the end of June and at intervals until December. The petioles of the youngest fully emerged leaf was collected from 26 plants in each plot. Macerate from 20 petioles was

https://doi.org/10.23637/ERADOC-1-124

TABLE 12

Sugar yields and per cent sugar of beet sown and harvested on different dates

Sowing date	Lifting date: 29 Sept. cpa	%	3 Nov. cpa	%	8 Dec. cpa	%	Mean cpa	%
27 March	57·5	17·2	68·1	19·1	69·6	17·0	65·1	17·8
17 April	56·8	17·4	65·6	19·3	68·1	16·9	63·5	17·8
2 May	51·7	17·2	64·0	18·9	63·6	16·8	59·8	17·6
Mean	55·3	17·3	65·9	19·1	67·1	16·9	62·8	17·7

distilled with titanous sulphate and the values of nitrate compared with the averages of six 'field' determinations on individual petioles by a colour test with diphenylamine reagent. The values from the two methods were usually similar, but although the diphenylamine tests could be done in the field and were much simpler and quicker, they gave more erratic results than the laboratory method.

At the end of June, petioles from plots without nitrogen fertiliser contained S_1—150, S_2—250 and S_3—450 ppm nitrate whereas from plots given 1·80 cwt/acre N they contained S_1—550, S_2—650 and S_3—700 ppm, all by the laboratory method. By mid-July, petioles from plots not given nitrogen were all <150 ppm, whereas those from plots with 1·80 cwt/acre N still contained S_1—300, S_2—350 and S_3—550 ppm. From early August until harvest, petioles from plots without nitrogen contained a constant amount of nitrate of about 100 ppm. Petioles from plots given 1·80 cwt/acre N still contained about 200 ppm at the end of October.

For maximum sugar yield the concentration of nitrate needed at the end of June was S_1—300, S_2—400 and S_3—550, in the middle of July S_1—150, S_2—200 and S_3—300 and from early August onwards a constant value of about 150 ppm. These results confirm experience in the U.S.A., where 2 to 3 months nitrogen 'deficiency' before harvest is necessary for maximum sugar yield. (Draycott and Wright)

Herbicides

In Little Lane field, Mr. W. E. Bray of Norfolk Agricultural Station tested different combinations of several doses of 'Pyramin' or 'Venzar', applied at sowing, and of 'Betanal' applied after the beet had emerged. Untreated plots were infested with weeds, and the herbicide increased yield by about 10 cwt/acre of sugar. Mean yield was about 68 cwt/acre of sugar (18 tons/ acre of roots at 19% sugar).

The plots where trifluralin distorted sugar beet in 1968 (*Rothamsted Report for 1968*, Part 1, 292) were cropped with sugar beet, potatoes, carrots, wheat and barley, but no residual effect of the chemical on yield or appearance of the crops was detected.

Hormone weedkillers. To estimate the effect of small doses of herbicides, such as may drift to beet crops when spraying cereals, or come from contaminated sprayers, sugar beet were sprayed either 6 or 10 weeks after

https://doi.org/10.23637/ERADOC-1-124

sowing with MCPA, MCPB or 2-4D, either at 1/20 or 1/50 the concentration recommended for cereals. MCPA and 2-4D were then sprayed at 1/100 the usual concentration 10 weeks after drilling. At 1/20 all the herbicides severely distorted the plants on both occasions; at 1/50 there was some but less distortion. Spraying with 1/20 concentrations 6 and 10 weeks after sowing decreased sugar yield by 6 and 11% with MCPA; 10 and 8% with MCPB; 12 and 7% with 2-4D. The 1/50 and 1/100 concentrations also slightly decreased yield and no spray increased it. In another trial beets were sprayed once on different occasions at weekly intervals with MCPA at 1/20 the recommended concentration between 21 May (6 weeks after sowing) and 4 July (12 weeks after). Every spray severely distorted the plants. Sprays in mid-June, 9 or 10 weeks after sowing, caused the greatest (14% sugar) yield loss. (Byford)

Cereal and rotation experiments

Fertilisers on rotation crops. This was the fifth year of the long-term experiment that tests fertilisers applied during a rotation of sugar beet, winter wheat and barley. (For the fertiliser dressings, see *Rothamsted Report for 1965*, 279, Table 7). As usual all three crops gave a large response to N_1 (Table 13), and only barley needed the N_2 dressing. Sugar beet responded to P and K but cereal responses were small and variable. Sodium and FYM increased sugar yield but neither greatly affected yields of cereals. The large dressing of compound (C_2) gave no more yield than the smaller (C_1) dressing. (Draycott and Durrant)

TABLE 13

Yield responses of crops to fertiliser treatments in the fifth 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	31·7	31·0	50·2
Response to:			
N_1	+11·0	+11·9	+7·1
N_2–N_1	−0·2	+2·2	−2·6
P_1	−0·5	+0·6	+2·3
P_2–P_1	+1·3	−0·1	−4·6
K_1	+0·4	+1·0	+8·9
K_2–K_1	+1·4	−1·1	+2·2
Na	+1·1	−1·1	+5·8
FYM	+1·8	−0·7	+5·8
Compound 1	+9·7	+14·6	+14·1
Compound 2–Compound 1	−2·0	−3·3	+0·3

Frequency of beet and barley. In this phased rotation experiment (*Rothamsted Report for 1968*, Part 1, 294), none of the effects of crop rotation on yield obtained in 1968 recurred. Continuous beet yielded the same (51 cpa of sugar) as beet in arable rotations, none of which differed from any other. Beet after grass yielded more (58 cpa) than beet in the arable rotations. Sugar yield was greater with N dressings up to 100 units/acre

https://doi.org/10.23637/ERADOC-1-124

but less with 150 units/acre. Barley (29 cpa) and potato (13·7 tpa) yields were unaffected by N given to beet earlier in the rotation, but beans yielded less, though not significantly, where N had been given. The first, second, third and fourth barley crops yielded respectively 33·6, 30·5, 26·6 and 27·3 cwt/acre. (Hull)

Effect of residues from beet on barley. In 1968 sugar beet was grown on Brome Pin field without N and with 50, 100 or 150 units N/acre; this N increased root yields from 17·1 to 20·7 tons/acre and sugar from 57·3 to 66·2 cwt/acre. N increased the yield of tops from 10·0 to 22·3 tons/acre and the N in them from 0·68 to 1·63 cwt N/acre; they were either carted away or spread and ploughed-in.

In 1969 Sultan barley was grown without N and with 33, 66 or 100 units N/acre, in all combinations with the N given in 1968, and with or without the ploughed-down sugar beet tops.

TABLE 14

Yields of barley after sugar beet, cwt/grain/acre at 15% moisture content

	N applied in 1968 (units/acre)				
Tops ploughed-in	0	50	100	150	
Without	35·6	37·3	37·1	36·2	±1·12
With	36·1	38·6	40·1	38·8	
	N applied in 1969 (units/acre)				
	0	33	66	100	
Without	23·4	37·2	42·3	43·1	±0·87V
With	28·8	37·6	43·2	44·1	±0·72HI

The residues from the N given in 1968 for the sugar beet increased barley yields most when the barley was not given N and least when it was given 1·0 cwt N/acre (Table 14). The residues from 1·5 cwt N/acre increased grain yields by only 0·6 cwt/acre when the sugar beet tops were carted off, but by 2·7 cwt/acre when they were ploughed-in. Similarly the tops of sugar beet grown without N increased grain yields by only 0·5 cwt/acre, whereas those given 1·5 cwt N/acre increased yields by 2·6 cwt grain/acre. The tops increased yields most (5·4 cwt grain/acre) when the barley was not given N and least (1·0 cwt grain/acre) when it was given 1·0 cwt N/acre; consequently, they diminished the response to the N applied for the barley from 19·7 to 15·3 cwt grain/acre. (Widdowson)

Fungicide on barley. The effect of ethirimol (supplied by Plant Protection Ltd., as 'Milstem') on the incidence of powdery mildew and yield of barley was tested in Flint Ridge field. Varieties Sultan and Zephyr with fungicide applied as a seed dressing at 12 oz or 32 oz/cwt, equivalent to 14 oz or 40 oz a.i./acre, were sown on 3 April. All plots were given 70 units N/acre in the seedbed and some an additional 40 units/acre top dressing on 2 June.

Birds caused considerable damage by uprooting seedlings, especially of Zephyr. They attacked the plots with treated seed less than untreated.

https://doi.org/10.23637/ERADOC-1-124

By 5 May the plant stand of Zephyr was only 2/3 that of Sultan; the untreated Zephyr had approximately 2/3 as many plants as on the treated plots, but the dressing did not affect the stand of Sultan. Mildew developed on untreated Zephyr and was effectively controlled by the seed dressing, but did not develop on untreated Sultan. The fungicide gave a large yield response with Zephyr (Table 15) and a small one with Sultan. On average, Sultan yielded 9 cwt/acre more than Zephyr. Both varieties responded to the extra N, but Zephyr more than Sultan. (Jaggard)

TABLE 15

Effect of ethirimol seed dressing on the yield of barley

(cwt/acre grain at 85% dry matter)

Seed dressing	Sultan N_1	Sultan N_2	Zephyr N_1	Zephyr N_2	S.E.	Mean	S.E.
Nil	35·7	37·8	26·6	27·3	—	31·9	—
12 oz/cwt	37·6	39·3	29·9	36·0	±1·02	35·7	±0·57
32 oz/cwt	37·5	38·7	32·0	38·1	—	36·6	—
Mean	37·0	38·6	29·5	33·8	±0·59		

Broom's Barn farm

Ploughing was completed by 8 January but wet weather and soil delayed spring work until early March. Dunholme field was deep cultivated in late July after the hay crop was removed. The ley, the sugar-beet irrigation trial and all the commercial beet were watered during the summer. The north half of Marl Pit had an additional dressing of lime in mid-February after ploughing because the surface soil was still acid. Acid areas of Dunholme were limed in mid-August after farmyard manure had been ploughed in. A few acres remained unploughed at the end of the year.

Cereals. Flint Ridge and Brome Pin were sown with 1½ cwt/acre Sultan barley during the last week in March. Flint Ridge was combine drilled with 3½ cwt/acre of 20 : 10 : 10 compound and was undersown with 14 lb/acre Italian ryegrass and 6 lb/acre red clover. The east part of Brome Pin was combine drilled with 3½ cwt/acre 20 : 10 : 10 compound and the west (low P-K area) with 1½ cwt/acre and top dressed with nitrogen to bring it up to 70 units N/acre. All barley plots were drilled by 3 April. The Cappelle wheat on Windbreak, Hackthorn, New Piece and The Holt and the Joss Cambier wheat on White Patch were top dressed with 80 units/acre of N as 'Nitram' during the second week of April. During the first 3 weeks of May, all cereals were sprayed with 'Banlene Plus' except the undersown barley on Flint Ridge which was sprayed with 'Legumex Extra'. Some of the Cappelle wheat lodged badly and some barley to a lesser extent. Harvest started with the Joss Cambier on 11 August and continued with the barley, then the Cappelle wheat, finishing on 8 September. Moisture content of the grain ranged from 13·5 to 20%. Table 16 shows yields, acreages and varieties.

Winter wheat was drilled between 15 and 24 October on Dunholme, Windbreak, New Piece and Bullrush, but germinated patchily and slowly

https://doi.org/10.23637/ERADOC-1-124

because the seedbed was very dry and lumpy. Most had germinated by the end of the year but growth remained uneven.

Beans. Bullrush was drilled with 1¾ cwt/acre of Maris Bead tic beans and 2 cwt/acre of a 0 : 20 : 20 compound fertiliser on 25 March and sprayed with 1·5 lb/acre of 'Gesatop' 8 days later, which controlled weeds well but also killed some beans. 'Dimaz' was applied on 5 July from a helicopter to control black fly. Harvesting was on 20 and 21 September and the straw was spread with a forage harvester and ploughed in.

TABLE 16

1969 cereal and bean yields at 15% moisture content

Brome Pin	24·1 acres	Sultan Barley	38¼ cwt/acre
Flint Ridge	21·8 acres	Sultan Barley (undersown)	34¼ cwt/acre
White Patch	1·5 acres	Sultan Barley	40 cwt/acre
	21·0 acres	Joss Cambier Wheat	34 cwt/acre
Windbreak	4·0 acres	Cappelle Wheat	42½ cwt/acre
Hackthorn and New Piece	22·6 acres	Cappelle Wheat	39 cwt/acre
The Holt	11·0 acres	Cappelle Wheat	33 cwt/acre
Bullrush	11·4 acres	Maris Bead Beans	23½ cwt/acre

Fodder crops. The Italian ryegrass and clover mixture on Dunholme received 3½ cwt/acre of 17 : 11 : 22 compound on 10 March and a further 3 cwt/acre of 17 : 11 : 22 compound on 18 April. Silage making lasted from 28 May to 4 June. The field was immediately top dressed with 40 units N/acre and given 1½ in. of irrigation. A hay crop was taken by mid-July.

The new ley under the barley on Flint Ridge established well although some of the barley was laid.

Sugar beet. The basic fertiliser on Little Lane and Marl Pit fields was 6 cwt/acre Kainit applied in the autumn and 6 cwt/acre of 20 : 10 : 10 compound on the seedbed. Sowing started on 27 March and finished on 2 May. All the crop was sown with graded seed, 20 acres with monogerm seed sown at 5 in. spacing. Most of the crop was band sprayed with 'Pyramin', the rest with 'Betanal' after emergence. Insecticide was sprayed twice to control aphids and yellows. Lifting started on 29 September and continued through the autumn, sometimes on very hard, dry land at first, but the land was saturated by the finish on 11 December. All undelivered roots were clamped on the loading platform. Yields averaged 13·7 tons/acre of clean roots, at an average sugar content of 18%, ranging from 15·6 to 20%. Mean dirt and top tare were 6·0 and 9·9 lb/cwt. The country's average yield this year was 13·6 tons/acre of roots at 16·9% sugar.

Livestock. During early October 1968, 59 Hereford-cross steers at an average live weight of 622 lbs, and 19 Hereford-cross heifers, at an average live weight of 628 lbs, were bought for fattening. All were fed *ad lib* silage, hay and a 75% barley : 25% beet pulp concentrate ration up to a maximum of 8 lb/head/day for the steers and 5 lb/head/day for the heifers. In the early stages a protein supplement was added to the concentrate ration. The average liveweight gain was 1·6 lb/head/day for the steers and

https://doi.org/10.23637/ERADOC-1-124

1·5 lb/head/day for the heifers. The average selling weight for steers and heifers was 948 lb and 841 lb liveweight respectively. All cattle were sold between 23 January and 27 May. Thirty-five Hereford-cross steers and 41 Hereford-cross heifers were bought in early October 1969. (Golding)

Staff and visiting workers

K. W. Jaggard was appointed in September. Two Sandwich Course students, T. E. Chalk (University of Bath) and R. A. Harding (Liverpool College of Technology) were with us for six months.

R. A. Dunning and R. Hull attended the International Institute of Sugar Beet Research Winter Congress at Brussels in February, and R. Hull the joint meeting of this organisation with the American Society of Sugar Beet Technologists in Germany in May; the American Society visited us in June. About 120 visitors attended our Open Day in June. The National Agricultural Advisory Service Plant Pathologists came for a one-day course in September and the N.A.A.S. Field Experiments Committee in June.

https://doi.org/10.23637/ERADOC-1-124