ROTHAMSTED RESEARCH

Report for 1975 - Part 1

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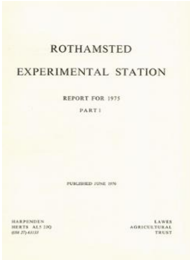
ROTHAMSTED
EXPERIMENTAL STATION
REPORT FOR 1975
PART 1

Broom's Barn Experimental Station

R. Hull

R. Hull (1976) *Broom's Barn Experimental Station ;* Report For 1975 - Part 1, pp 53 - 81 **- DOI: https://doi.org/10.23637/ERADOC-1-132**

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Introduction

For the second year in succession, growers have struggled against unfavourable weather for the sugar-beet crop and achieved only a parlous yield. The wet, mild weather during the winter and spring resulted in such unfavourable soil conditions that much of the 1975 sugar-beet crop was not sown until mid-April or later. The problems of water-logged soil that caused harvesting difficulties in 1974 persisted until and during sowing in 1975. At Broom's Barn the first sowing was 21 April, about five weeks later than normal. On 2 June much of the main sugar-beet growing area in eastern England was covered with snow for several hours. Although soil moisture returned to field capacity in mid-May, the backward crop could take little advantage of it. In contrast, throughout the summer and autumn, growth was very severely restricted by drought.

In these unusual circumstances the nitrogen nutrition of the crop was difficult to

https://doi.org/10.23637/ERADOC-1-132

interpret on some experiments. Measurements showed that the rain which delayed sowing, leached fertiliser N that had been applied earlier. This, in conjunction with badly structured top-soil restricted rooting and mineralisation of soil N, resulted in plants with a very small N concentration in spite of having received large dressings of N fertiliser. The irrigation experiment, however, showed a large response to fertiliser N with water applied early in the summer, but little response to N without water, an unusual interaction at Broom's Barn. Few sugar-beet crops in eastern England produced enough leaf to cover the ground due to the summer drought and responded little to rain in the autumn, which suggests that the plants were unable to get an adequate supply of either N or water from the soil this year.

Late sowing, poor physical condition of the soil and drought were the most important factors leading to the English sugar-beet crop, like that of much of Western Europe, yielding far below average.

Aphids were again numerous in July and virus yellows became prevalent in the late summer. Incidence was only half that of 1974, but as much as in any of the previous years so yellows, too, very considerably restricted yield. Insecticide treatments usually increased yield by delaying infection but were not effective enough to contain it. Some infestations of *Myzus persicae* had developed resistance to organo-phosphorus insecticides. Traps caught only a few winged *M. persicae* during the autumn, so there is no present augury of yellows spreading early in 1976. A hard winter could improve prospects for a yellows-free crop in 1976, but a mild one could deteriorate them, especially since there would be a large carry-over of yellows-infected plants.

During the summer the foliage of beet crops almost throughout the country was infected by powdery mildew (*Erysiphe betae*). Light and late infection with this disease has been common in recent years, but never has it been so prevalent as this year. A disturbing feature is that infected leaves are now covered with cleistothecia (resting spores) which were not found in this country until recently. This suggests that inoculum will be widespread and the disease may well reappear if weather favours it; however, most summers in England do not.

In a few fields wild annual beets have become a prevalent weed. In the seedling stage they are indistinguishable from sugar-beet, but they soon bolt and produce seed. They have been introduced in hybrid triploid monogerm seed which is produced by fertilising diploid male sterile mother plants with pollen from tetraploids. Pollen from tetraploid plants is released later in the day than diploid, so the mother plants can readily be fertilised by pollen from wild plants in early morning. Further introduction of wild beets can be avoided by testing the seed supplied to growers, but the means of eliminating soil contamination with seed and preventing the weed beets which come up for several years when once the soil is contaminated, will be the subject of an intensive research effort.

Arthropod pests of seedlings

Damage by slugs and leatherjackets was above average but other pest damage was minimal, a consequence of late sowing and probably also of increased use of the insecticides gamma-BHC, aldicarb and oxamyl on fields with pest problems.

Pygmy beetle dispersal. The Broom's Barn suction trap caught only 184 beetles; in six years of study the previous minimum was 566 in 1972. The Broom's Barn sticky trap caught 287, fewer than average, a pattern repeated at Rothamsted and Shardlow. Nevertheless, the time and pattern of dispersal was similar to that of previous years. Damage to crops was slight, despite late drilling. (Thornhill and Dunning)

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Seed treatment. Fifty trials in 15 sugar factory areas measured the seedling establishment achieved from pelleted 'Monotri' seed carrying the standard 0·2% of dieldrin, 0·05, 0·1, 0·2, 0·4 and 0·8% of methiocarb, and 0·05, 0·1, 0·2 and 0·8% of bendiocarb and of 'PP505', all incorporated during pelleting. In each area only one site was chosen where pest attack was expected from previous history. Seedbeds were much better than in 1974 but most of the trials, in common with much of the beet crop in 1975, were sown late (20 April mean). Laboratory germination of the seed was 79% and, on average, field establishment from untreated seed was 52%. Averaging all trials, 0·2% dieldrin, 0·05 and 0·2% methiocarb and 0·05, 0·1 and 0·2% bendiocarb significantly increased seedling numbers by 2·9, 5·0, 4·2, 3·3, 4·4 and 5·2% respectively; other treatments increased seedlings less or decreased them slightly.

At Broom's Barn and three other sites in East Anglia, the same treatments were tested with and without aldicarb granules in the seed furrow at 560 g a.i. ha^{-1}. At Broom's Barn all treatments increased seedling numbers, the following significantly: 0·05, 0·2 and 0·8% methiocarb by 23, 24 and 19%; 0·2% bendiocarb by 15%; 0·05, 0·1, 0·2 and 0·8% 'PP505' by 21, 32, 16 and 25% respectively. Aldicarb further increased seedling numbers on all treatments, on average by 10%.

Results at the other three sites were more variable; seed treatment tended to increase seedling establishment at New Buckenham (beet after beet) but to decrease it at Stalham and Terrington Marsh. Averaging the results of these four trials, seed treatment effects were insignificant but aldicarb alone increased seedling numbers by 9%. As a result, several of the seed treatments when used with aldicarb had significantly more seedlings than the untreated control: 0·2% dieldrin, 10%; 0·05, 0·1, 0·2 and 0·8% methiocarb, 15, 10, 10 and 10%; 0·1 bendiocarb, 16%; 0·1 and 0·8% 'PP505', 10 and 10% respectively.

All seed is treated with insecticide, currently 0·2% dieldrin or methiocarb, to give the seedlings some protection against any seedling pests present. Aldicarb, in addition to any seed treatment, had no adverse effect at any site; in general such a combined treatment was very beneficial.

'Monotri' seed carrying 0·4 and 4% of carbofuran in the pellet was also tested at two sites, with and without aldicarb granules. On average 0·4% carbofuran alone increased seedling establishment 22% but 4% carbofuran decreased it 23%. Aldicarb alone had no effect; with the 0·4% carbofuran-treated seed it negated the beneficial effect but did not increase the adverse effect of the treatment. Leaf scorch and decreased seedling vigour occurred with the 4% carbofuran-treated seed, both with and without the aldicarb. (Dunning and Winder)

Soil treatment. Aldicarb, oxamyl, thiofanox and carbofuran granules at 280 and 1120 g a.i. ha^{-1}, and terbufos granules at 280 g a.i. ha^{-1}, all sown in the furrow with the seed, were compared at three sites with 140, 280, 560, 1120 and 2240 g a.i. ha^{-1} of gamma-BHC sprayed at 660 litre ha^{-1} and worked into the seedbed immediately prior to sowing.

At Stalham, where *Onychiurus* was present, seedling establishment was 59% on the untreated plots. No treatment increased seedling numbers; carbofuran and thiofanox (1120 g a.i. ha^{-1}) and terbufos (280 g a.i. ha^{-1}) decreased seedling emergence 15, 34 and 58% respectively.

At New Buckenham (beet after beet) 41% of the seed sown produced seedlings. All treatments except oxamyl (1120 g a.i. ha^{-1}) increased seedling numbers; gamma-BHC (2240 g a.i. ha^{-1}), carbofuran (280 g a.i. ha^{-1}) and terbufos (280 g a.i. ha^{-1}) increased numbers significantly by 20, 24 and 19% respectively.

At Terrington Marsh seedling establishment was only 34%, probably due to an unsatisfactory seedbed, and it was not affected by any treatment.

Averaging the results of the three trials, treatments affected seedling establishments as

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follows: gamma-BHC sprays at 140, 280, 560, 1120 and 2240 g a.i. ha^{-1} + 4·0, + 6·9, + 3·1, + 12·1 and + 5·8%; aldicarb granules at 280 and 1120 g a.i. ha^{-1} by 0 and − 2·2%; oxamyl granules by + 7·6 and − 1·8%; thiofanox by + 8·0 and − 6·5%; carbofuran by + 6·2 and − 4·9%, and terbufos at 280 g a.i. ha^{-1} by − 22·1% respectively.

In the 1975 trials granular pesticides in the seed furrow were less consistent in effect than formerly; as in most previous years the response to gamma-BHC dipped at the 560 g rate. (Winder and Dunning)

Bird and mammal damage

Taking of seeds by wood mice and grazing of seedlings by birds and mammals was significant only on early-sown crops. Nationally, damage was less than average, probably because the crop grew quickly after late sowing. Moisture was ample, germination was rapid and seedlings soon passed through the susceptible stages.

Seed digging and seedling grazing were accurately measured on 11 pre-selected Cambridgeshire and Suffolk farms and, in addition, fields where sugar factory fieldmen reported severe damage were inspected. In only one of the pre-selected fields was seed digging by mice noted, and it was rare in other fields, although wood mice were present on all. In one reported field, 25–30% of seeds were dug out of some areas by wood mice. In two of the 11 pre-selected fields seedling grazing was relatively severe. Observations and exclusion caging indicated that birds (skylarks and partridges) were mainly responsible but faecal analysis showed that these species were also taking many other foods. Grazing by mice was not important; a survey of wood mouse densities on sugar-beet fields showed a very rapid decline in the spring and few remained in May when the beets were in the seedling stage.

Ecological studies

Wood mouse. Continuing a population study on Broom's Barn Farm, started in 1974, mice were live-trapped at monthly intervals throughout the year. All the animals caught were individually marked by toe-clipping, weighed, and then sexed and reproductive condition determined. Wood mice were common (10 ha^{-1} or more) on most of the fields sampled in the 1974–75 winter with densities declining steadily after breeding stopped in October. In April and May numbers fell sharply, especially on open, cultivated fields, although cultivation itself did not appear to cause the decline.

Although young were produced from April to October there was little recruitment into the breeding population in spring and early summer, possibly because of juvenile mortality. The population was therefore small throughout the summer but increased rapidly in the autumn. Sampling of wood mouse populations using snap traps indicated that the sharp decline in numbers in spring at Broom's Barn occurred elsewhere in Suffolk and Cambridgeshire. Samples of stomach and caecum contents contained remains of cereal grain, other seeds, leaves, roots and insects.

Skylark. Skylarks were counted at least monthly on the three farms selected in 1974, (*Rothamsted Report for 1974*, Part 1, 51). In both summer and winter, birds gathered to feed on fields with the most abundant food. Observations in summer of skylarks marked with coloured tags showed that feeding often occurred outside their breeding territories, within the territories of other birds. On Broom's Barn Farm eggs were laid from April until July. Nesting success was very poor early in the season, but improved in June and July. Samples of faeces from the three study farms were collected regularly and showed that foods include grain, seeds, leaves, grass-flowers and insects. The proportions of these different foods in the samples fluctuated seasonally and there were also consistent

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differences between the three farms. It was possible to relate these changes and differences to food availability. Faeces of captive skylarks fed on known diets were also analysed, allowing estimation of the relative destructabilities in the gut of fragments of different foods. This work should improve the accuracy of the faecal analysis technique. (Green)

Alternative food. Fodder rape, sown between the rows of beet on 24 April, grew well and gave complete inter-row cover; it was removed on 12 June before it seemed to be competing with the beet. Subsequent growth of beet on these plots was poor, despite irrigation; virus yellows incidence was increased by 37% and sugar yield decreased by 19%. The fodder rape provided alternative food for birds and mammals, especially wood pigeons, which were attracted to the trial area but grazed the beet more on the plots with fodder rape.

In the same trial aldicarb granules (840 g a.i. ha^{-1}) applied in the seed furrow followed by foliar sprays of demeton-S-methyl (245 g a.i. ha^{-1}) plus pirimicarb (140 g a.i. ha^{-1}) on 12 and 25 June decreased virus yellows incidence by 50% and increased yield by 11%. (Dunning, Winder and Thornhill)

Wood mouse poisoning. Chlorophacinone ('Drat') was tested as a poison for wood mice on 2 ha at Broom's Barn in February–March. Most of the mice present before baiting had disappeared afterwards but they were rapidly replaced by others. Such immigration may not be so marked on larger areas. (Green)

Yellows and aphids

Yellows was again prevalent in 1975 with an estimated 59% of sugar-beet plants showing symptoms at the end of September (compared with 76% in 1974) but spread was much later than in 1974 and therefore less damaging. It was difficult to assess yellows incidence in autumn in some fields due to loss of leaves from drought and an unusually severe attack of powdery mildew. At the end of July only 6% of the plants had symptoms nationally (compared with 42% in 1974) although in the Ely factory area some fields were already severely affected. At the end of August incidence was 37%, compared with 66% in 1974. With a similar number of frosts during January to March and similar April temperatures in 1974 and 1975, an equally severe attack of yellows had been feared, but late May 1975 was cold, snow fell at Broom's Barn on 2 June, and this delayed aphid multiplication and flight. (Heathcote and Byford)

About 91% of the sugar-beet acreage had one or more foliar treatments with insecticide against aphids and yellows. Spray warnings were issued promptly and, on average, each crop was sprayed more than once with an aphicide, mainly demeton-S-methyl or pirimicarb, and 28% of the acreage was treated with soil-applied aldicarb or oxamyl. These insecticides did not remain effective long enough to prevent late spread of yellows. The control of green aphids and yellows on some crops achieved with organo-phosphorus insecticides was disappointing.

Effect of yellowing viruses on yield. Plots of var. Vytomo and of Monotri were infested with aphids carrying yellowing viruses in mid-June to induce widely different levels of infection. All plots were sprayed with insecticide later to limit the natural spread of yellows. In mid-July the naturally-infected plots had about 2% of plants showing symptoms compared with about 90% of the plants in the most heavily infected plots, but by late September it was no longer possible to distinguish between treatments; most of the crop showed indefinite yellowing, a consequence of drought and a severe attack of powdery mildew.

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The root yield of the most heavily infected plots was 28% less than that of plots kept as free as possible from infection, and the sugar concentation was decreased 0·5%. Vytomo had a greater plant population than Monotri (109·1 : 102·3 thousand harvestable roots ha^{-1}) and a greater sugar percentage (17·8 : 17·6), but the root yield from 'healthy' plots was less (46·3 : 48·4 t ha^{-1}) as was the total yield of sugar (8·3 : 8·5 t ha^{-1}).

Overwintering aphids and viruses. Surveys determined the numbers of the aphid species liable to infest sugar-beet crops that over-wintered on secondary host plants. Because of the severe attack of yellows in 1974 the annual cooperative survey with BSC of over-wintering weeds and of mangold clamps was reintroduced and, in cooperation with ADAS, oil-seed rape crops were surveyed. Samples of *M. persicae* from many crops were sent to Rothamsted or the Royal Free Hospital where the proportion that were resistant to organo-phosphorus insecticides was determined by bioassay or gel electrophoresis.

More mangold clamps were infested in April (57%) than in any year from 1963 to 1972 but mangolds were used early, and the mangold acreage has continued to decline, so that clamps were probably only a minor source of yellows. Aphids were found on 74% of samples of weeds (mainly chickweed, groundsel or shepherd's purse) collected in April, many more than the average for previous surveys (40%).

Numerous *M. persicae* were found on some sugar-beet seed crops in Oxfordshire and Buckinghamshire in mid-June, and moderate infestations in Bedfordshire. Not all the crops had been sprayed with insecticide in the spring, but on others that had been sprayed, organo-phosphorus aphicides failed to control the infestation. *A. fabae* were rare on seed crops until mid-July.

Many sugar-beet 'groundkeepers' survived in the field after the difficult harvest of 1974 and grew in the following crops. In the Bury St. Edmunds area, 395 beet plants ha^{-1} on average were found in March and April in cereal crops that followed sugar beet, but few survived the dry summer and an average of 14 ha^{-1} grew in the stubble after harvest. Although most of these groundkeepers had yellows, very few were infested with aphids.

The acreage of overwintering crops of oilseed rape has increased rapidly, and rape plants are also common at the roadside in eastern England, but few aphids overwintered on them. Few late-sown crops were infested, and early-sown crops had no more than two *M. persicae* per plant on average. However, a crop of black mustard in Cambridgeshire was heavily infested in May (six per leaf). Few *M. persicae* were found on other Brassica crops.

No *M. persicae* eggs were found on ten peach trees in March, and *A. fabae* eggs were few on spindle bushes at most of the 20 sites checked in East Anglia (although at Broom's Barn there were two eggs per bud). Economic damage by blackfly was considered unlikely in East Anglia, as in all areas studied by entomologists cooperating in the Imperial College survey. At Broom's Barn only an occasional field-bean plant was infested at the end of June and, although the pest infested sugar beet in late July, ladybirds (*Coccinella 7-punctata*) rapidly destroyed it.

Time of aphid flight. More than twice as many winged *M. persicae* were caught on sticky traps in sugar-beet fields in 1975 as in 1974, mostly in the third week of July (when the suction trap at Broom's Barn caught more *M. persicae* than in any week since 1965) some three weeks later than in 1974. In June 140 *M. persicae* were trapped at Woburn, 18 times as many as the average of the other traps. Few *A. fabae* were trapped in the beet-growing region. (Heathcote)

Time of spraying. Aldicarb sown with the seed controls early aphid infestation, but little is known about the need and timing of subsequent insecticidal treatment to control later

https://doi.org/10.23637/ERADOC-1-132

aphid invasion and yellows spread. At Broom's Barn, on plots with and without aldicarb (7850 g a.i. ha^{-1}) in the seed furrow at sowing on 29 April, six different times of spraying were compared. In an attempt to avoid any problems of organophosphorus-resistant aphids the spray used was demeton-S-methyl (245 g a.i. ha^{-1}) plus pirimicarb (140 g a.i. ha^{-1}) applied in 450 litres ha^{-1}. Sprays were applied, at shorter intervals early in the season and longer ones later, on 28 May, 5, 12, 25 June, 8 and 25 July. On 22 May, 6, 13 and 27 June, 2, 10 and 25 July there were 0·05, 0·2, 0·2, 4·5, 5·7, 32·0 and 0·9 apterous *M. persicae* per plant respectively on the control plots. On the 6, 13 and 27 June and 2 July there were 0·02, 0·8, 2·0 and 5·8 per plant on the aldicarb-treated plots. Aldicarb alone increased seedling population and vigour, decreased yellows incidence (670 infected-plant-weeks) slightly and increased sugar yield by 5%. The spray alone did not affect yellows incidence or yield when applied on 28 May or 25 July; it gave approximately equal benefit when applied on any of the four intervening dates, increasing yield by 9·5% on average. Following aldicarb treatment, the first spray decreased yield, the subsequent three equalled the spray alone but the fifth spray, on 8 July, after aldicarb increased yield by 16%. The sixth spray was also beneficial after aldicarb, despite the fact that the aphids had then left the crop. All six sprays together decreased yellows incidence the most, but only by 27%, whether with or without aldicarb, and did not increase yield more than did aldicarb plus the 8 July spray.

Similar results were obtained in the six British Sugar Corporation's trials, where an early spray increased yield by 4% on average, but a late spray, with or without aldicarb, by about 10%. The value of late spraying needs testing in different seasons; it may be that the secondary migration is particularly important in spreading yellows in those years when only little is brought into the crop by the primary migration. (Dunning and Winder)

Effect of aldicarb on yellows and on yield. On five trials in cooperation with ADAS in Cambridgeshire and in Suffolk, the average yield of roots was increased from 18·4 to 24·7 t ha^{-1}, and the sugar content from 14·4 to 14·8% by treatment with about the recommended rate of aldicarb at sowing. There seemed little difference in the yellows incidence in August on treated and untreated plots. Treatment increased the plant population from 63·0 to 70·5 thousand harvestable roots ha^{-1}. (Heathcote)

Insecticides. Four trials in East Anglia compared the efficiency of green aphid and virus yellows control by commercial spray materials at recommended rates, applied at the times of the first and second spray warnings for the area (mean dates 13 June and 5 July). Averaging results from the first spray, pirimicarb controlled aphids best (72% decrease); others were less effective or even increased numbers. Pirimicarb and demephion were the most effective at the time of the second spray and all other materials, except formothion, gave some control. Despite two sprays, the maximum control of virus yellows incidence was only 27% by pirimicarb and demephion; control by other materials was less, and insignificant by formothion, phosphamidon and thiometon. For most materials, these results parallel those obtained in 1974 and, for demeton-S-methyl, dimethoate, formothion, menazon and phosphamidon, results obtained in 1959–61. Hot, dry conditions, as in the spraying season of 1975, are typical of years when green aphids and yellows are severe. For such conditions, and in the likely presence of some aphids that are resistant to organophosphorus materials, the efficiency of the spray materials can be ranked. Groups are, in decreasing order of effectiveness: pirimicarb; demephion and demeton-S-methyl; menazon; dimethoate; formothion, phosphamidon and thiometon.

The aphicidal effect of aldicarb and thiofanox granules applied at sowing on 17 July in the seed furrow at 280 and 1128 g a.i. ha^{-1} was determined by keeping aphids on the

https://doi.org/10.23637/ERADOC-1-132

foliage in leaf clip cages. At the larger rate thiofanox killed more aphids, and for a longer period, than did aldicarb; at the lower rate thiofanox initially killed more aphids, but both were ineffective by 17 August.

Resistance to aphicides. The surveys and trials started in 1974 were continued, and samples of *M. persicae* from fields both before and after treatment with aphicides were submitted to the Insecticides Department (see p. 157).

M. persicae were, in general, few on beet in June but many developed in the first half of July. As a result of the 1974 epidemic, growers probably over-reacted to spray warnings; many treated the crop more than the recommended once or twice.

In a field near Ely, Cambs., the grower applied demeton-S-methyl four times, twice in a band and twice overall. Three days after the fourth spraying control was far from complete, so a range of aphicides were sprayed at the recommended rates in 450 litre ha^{-1} the following day (1 July) when there were 13 apterous *M. persicae* per plant. On days 3, 8, 15 and 22, when there were respectively 130, 128, 174 and 5 apterae per plant on the untreated plants, the treatments decreased numbers as follows: 'AC 85258' (630 g a.i. ha^{-1}) 60, 84, 81, 78%; acephate (455) 82, 90, 98, 97%; demeton-S-methyl (245) 68, 71, 66, 63%; ethiofencarb (245) 63, 74, 86, 86%; methamidophos (252) 88, 85, 96, 96%; permethrin (280) 57, 88, 92, 70%; pirimicarb (140) 88, 93, 94, 89%. (Dunning, Winder and Thornhill)

Aphid predators. A trial at Broom's Barn with sugar beet sown on 24 April, compared spray applications, on 19 June and 8 July, of demeton-S-methyl (245 g a.i. ha^{-1} at each spray), permethrin (280 g) and pirimicarb (140 g), and the combination of aldicarb granules (785 g) applied in the seed furrow at drilling with the later spray of demeton-S-methyl. Decreases in the numbers of wingless *M. persicae* on the 10 July (7·7 per plant on the untreated plots) and 17 July (4·7) and of wingless *A. fabae* on 17 July (17·2) and 24 July (42·9) were demeton-S-methyl 50, 70, 73, 52%; permethrin 73, 82, 91, 71%; pirimicarb 95, 94, 73, 22%; aldicarb plus demeton-S-methyl 73, 58, 75, 70%. These treatments decreased the moderate incidence of yellows (320 i.p.w.) by 21, 51, 46 and 45% respectively.

The population of the predatory mite *Anystis* sp. (average of 1·1 mites per plant on control plots in three counts between 10 and 24 July) was decreased by the treatments of aldicarb plus demeton-S-methyl (86% decrease), demeton-S-methyl (89%) and permethrin (87%); pirimicarb decreased numbers by 48%. No other predator was seen in such large numbers.

During the four weeks after the second spray, pitfall traps caught consistently fewer small carabids, of several species, on the permethrin (62% decrease) and aldicarb plus demeton-S-methyl treated plots (44%) than on the control plots (mean of 4·8 per trap per week). The other two treatments did not greatly affect numbers of small carabids. Only permethrin increased sugar yield significantly, by 9%. (Dunning, Heathcote, Thornhill and Winder, with Stevenson, Insecticides Department)

Seedling diseases

Fifteen field trials compared fungicides applied as slurries to Monotri seed before pelleting to control *Phoma betae*. On average ethyl mercuric phosphate (EMP) steep increased seedling establishment by 23% compared with increases of 11, 7, 7 and 5% respectively from maneb at 1·07%, captafol at 0·64% and TCMTB at 0·1 and 0·15%.

Twenty seed samples with differing amounts of seed-borne *P. betae*, with or without EMP steep treatment, were grown in the field. Both the number of diseased seedlings

https://doi.org/10.23637/ERADOC-1-132

developing from untreated seed, and the increase in seedling emergence due to EMP steep were correlated with the proportion of seeds with *P. betae* determined in laboratory tests.

Powdery mildew

Powdery mildew (*Erysiphe betae*) was unusually prevalent and outbreaks, often severe, were reported from all beet growing areas of England. The disease caused the leaves to turn yellow and wither prematurely. Cleistothecia, which were unknown in England until recently, were reported from most regions by fieldmen, although four of the five fieldmen in the York factory area could find none.

Four trials at or near Broom's Barn tested the effect on yield of fungicides applied to control powdery mildew. In one trial sulphur at 11 kg ha^{-1} or 'Bayer 6660' at 0·25 kg a.i. ha^{-1} applied on 3 September had no effect on yield of tops or sugar on 6 October. Three trials compared one or two sprays with fentin hydroxide at 0·5 kg a.i. ha^{-1} with one or two sprays with 'Bayer 6660' at 0·25 kg a.i. ha^{-1}. The first sprays were applied in late August and the second in mid-September. At harvest in late October the sprays had, on average, decreased powdery mildew on the leaves by 44, 51, 64 and 69% respectively, increased top yield by 16, 15, 11 and 6% and sugar yield by 9, 1, 8 and 0% respectively.

Powdery mildew was scored in two variety trials at Broom's Barn, using a 0–5 scale assessing the proportion of plants heavily infected. The ten varieties on the NIAB recommended list were common to both trials, and there was good agreement between scores on them. The varieties with most infection were Hilleshog Monotri, Nomo and Vytomo, and those with least were Sharpe's Klein Megapoly and Bush Mono G. (Byford and Bentley)

Docking disorder

Docking disorder symptoms were reported on 1765 ha of sugar beet during June 1975. Most affected fields had not been treated with a nematicide and many had been sown during short breaks in the almost continually wet weather in March and April. The factory areas with the largest areas reported affected in June were York (607 ha), King's Lynn (388 ha), Bury St. Edmunds (303 ha) and Selby (231 ha).

The effectiveness of the carbamate-type pesticides (oxamyl and, especially, aldicarb) in delaying virus yellows infection in 1974, as well as their success in controlling Docking disorder, resulted in a great increase in their use in 1975. For Docking disorder control, these easily applied granular materials have now almost completely replaced fumigant injection, which slows and delays drilling. (Cooke)

At East Walton, Norfolk, granular nematicides were compared, as in-seed-furrow applications, on a site with 3100 *Trichodorus* per litre before sowing. Aldicarb and oxamyl, at 1120 g a.i. ha^{-1}, increased seedling numbers by 10 and 15% respectively (57% establishment on untreated) and improved the foliage vigour, but carbofuran decreased seedling numbers by 26%. Virus yellows incidence was decreased by all treatments at both rates of application (280 and 1120 g a.i. ha^{-1}), especially by the larger amount of thiofanox (24% decrease). All treatments, except thiofanox at 280 g a.i. h^{-1}, greatly decreased root fanginess. Control plots yielded 2·96 t ha^{-1} of sugar; aldicarb, carbofuran and oxamyl (each at 280 and 1120 g a.i. ha^{-1}) and thiofanox (1120 g a.i. ha^{-1}) increased yield by 30, 54; 39, 22; 29, 39; 30% respectively. (Winder and Dunning)

Crop growth in relation to nematode populations. For the fourth and final year the relationships between numbers of *Trichodorus* after seedling emergence and at harvesting, soil texture, root numbers, yield and shape were studied in five commercial sugar-beet crops. Twenty-five widely spaced plots in each field were sampled soon after seedling

https://doi.org/10.23637/ERADOC-1-132

emergence and immediately after harvest. One trial in the York factory area which contained numerous *Trichodorus* (average 1928 per litre of soil) and little silt + clay (average 7·8%) was lost from wind damage.

As in previous years there was no significant relationship between nematode numbers and soil texture on the fields with the lightest soils (silt + clay less than 17·5%) but at the Brigg site, where silt + clay ranged between 15·6–24·0%, numbers of *T. pachydermus* were fewer with increasing silt + clay and were absent at both samplings from the seven plots where silt + clay exceeded 21%.

The three trials at King's Lynn and Brigg all yielded poorly due to drought after seedling emergence rather than to nematode injury. In a York trial the uneven plant size and poor root shape indicated that nematode damage had occurred, but the poor seedling emergence in some plots caused by seedbed conditions masked any significant effect of nematode numbers on yield.

Stem eelworm. Three trials on fields where a previous onion crop had suffered damage by stem eelworm (*Ditylenchus dipsaci*) again tested three rates (0·28, 0·56, 1·12 kg a.i. ha^{-1}) of aldicarb and oxamyl applied in the seed furrow. The extremely dry conditions following drilling restricted nematode activity in the surface soil and no stem eelworm damage was apparent. At all sites the two higher rates of aldicarb decreased seedling numbers (by between 5·4 and 8·9%); sugar yields, which last year were increased by aldicarb delaying virus yellows infection, were not affected significantly by any treatment this year.

Beet cyst eelworm. Three trials tested three rates of aldicarb and oxamyl (2·8, 5·6, 11·2 kg a.i. ha^{-1}) broadcast and rotavated into peat soils (two near Ely, one near Wissington) infested with *Heterodera schachtii*, where commercial beet crops were grown under licence. All treatments decreased the numbers of larvae in plant roots sampled in June and, although severe beet sickness was not apparent in any trial, sugar yield was increased, especially by aldicarb, in the two trials harvested (Table 1). (Cooke)

TABLE 1

Effect of broadcast nematicides on sugar yield in soil infested with beet cyst eelworm, mean of two trials

Nematicide	Rate (kg a.i. ha^{-1})	Sugar yield (t ha^{-1})
none	—	5·10
oxamyl	2·8	5·29
	5·6	5·10
	11·2	5·14
aldicarb	2·8	5·39
	5·6	5·92
	11·2	5·84

Seed production

Diseases in seed crops. In 1975 the steckling certification scheme, which has been in force since 1951, was superseded by a seed crop inspection scheme under EEC rules. The purpose of steckling certification has been to ensure that seed crops are relatively free from disease so that they are not a major reservoir of infection for root crops. The primary purpose of the new scheme is seed certification, but it has proved possible to continue autumn disease counts in all steckling beds by combining them with the crop inspections.

In October, 89 sugar-beet steckling beds averaged 0·64% plants with yellows. Open *in-situ* beds in the Cotswolds and Bedfordshire had few plants with yellows but the

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plants were small and sparse. Eighty beds raised under cereal cover crops in the Eastern Counties averaged 0·7% and nine had between 1 and 10% of plants infected with yellows. Downy mildew was seen in only one steckling bed. (Byford)

Factors affecting seed yield

Nitrogen fertiliser. 'Nitro-Chalk' at 250 kg ha^{-1} was top-dressed on to sugar-beet seed plants in February, March, April or May or in split applications totalling 250 kg ha^{-1} in February and March, March and April, April and May or February and May. The experiment had two replicates on shallow oolitic limestone soil at Stonesfield, Oxon. Leaf petiole nitrate concentrations were determined monthly from March to June. Part of each plot was harvested on three occasions. Delaying harvest first gave more and then, as the optimum (27 August) passed, less seed but harvest date did not interact with nitrogen treatment and so the results have been averaged over the three harvests. Initially the crop had a leaf petiole nitrate nitrogen concentration of 730 ppm. This declined in general during the growing season except for a month following the application of nitrogen, when the value was increased to 500–600 ppm. The lowest values in June were 150 ppm on plots which had received nitrogen in February. Even so, treatments did not affect the yield of seed or its germination or monogermity. Size distribution was little affected by treatment, although there was a tendency for most seeds in the usable 3·25–4·00 mm diameter fraction to be from plots given single applications of nitrogen in March or April.

Roots and shoot removal. Tap roots were chopped off with spades to leave stecklings 75–100 mm long, or shoots were mown off, or both treatments were made either in November 1974 or March 1975 to plants growing at Spelsbury, Oxon. Shoot removal gave much shorter seed plants but did not affect seed yield. Cutting off the roots in the autumn or spring greatly reduced seed yield but increased the monogermity of the seed which was produced, probably because the treatment retarded growth and gave a greater proportion of lighter, thinner seed. Germination was not affected.

Herbicides. Treatments were applied by knapsack sprayer on 6 November 1974 to plots at Thorney Cambs. Seed plants were harvested on 21 August 1975. Despite unencouraging observations during crop growth, simazine treated plots gave more seed than the untreated controls. Carbetamide, propyzamide and TCA/propham treated plots gave similar yields of seed to the control plots and their seed was of slightly greater monogermity. Germination percentage and seed size distribution were not affected by treatments.

Factors affecting seed performance

Seed crop cultural practices. The effects of cultural practices applied to seed crops harvested in 1974 on seed quality were evaluated by field sowings in 1975.

Emergence was greatest from seed from plots given nitrogen in February at Thorney, but seedling weights were not affected. None of the nitrogen treatments at Stonesfield affected seedling emergence or weight.

Most seedlings emerged from seed taken from plants which had not had their roots pruned. Shoot removal appeared to have no effect. Pruning in the spring reduced emergence slightly more than pruning in the autumn. Seedling weights were not affected.

Emergence was 13% greater from seed harvested late from plants grown in rows 25 cm apart than from rows 50 cm apart. Delaying harvest date was more beneficial for plants in 25 cm than in 50 cm apart rows. Seedling weights were not affected.

https://doi.org/10.23637/ERADOC-1-132

Seed treatment. Crop establishment and growth might be better if seed was advanced, or chitted and fluid drilled (Currah, Gray & Thomas, *Annals of Applied Biology* (1974) **76,** 311–318). Experiments at Broom's Barn and Wellesbourne tested a range of treatments but they gave differing plant populations so the apparent effect of the treatments on growth of the plants and yield, although encouraging, were not definitely established by the experiment. (Longden)

An experiment on White Patch field tested the effect of time of sowing and pre-soaking of seed prior to pelleting on seedling emergence and yield of the varieties Amono, Bush Mono G, Nomo and Sharpe's Klein Monobeet. Sowing dates were (S1) 22 April, (S2) 30 April and (S3) 12 May. No plants on the experiment bolted. Pre-soaking the seed increased the rate of emergence in laboratory germination tests, but gave mixed results in the field; poor at S1, a slight improvement at S2 and a marked improvement at S3. Seed pre-soaking decreased plant density and hence, sugar yield at S1 by 0·34 t ha^{-1}, but at S3 increased sugar yield by 0·30 t ha^{-1}. Mean sugar yields for the sowings were S1 7·88, S2 7·69 and S3 6·56 t ha^{-1}. The variety Nomo gave the largest yields at all sowings viz. S1 8·22; S2 8·06 and S3 7·01 t ha^{-1}. (Webb)

Na and seed advancement. This was the third year of a study where the object was to improve early growth of sugar beet by reducing the time needed for emergence, and by decreasing the detrimental effects on seedling emergence of soluble fertilisers. An experiment on Hackthorn field tested the effect of all combinations of 0 and 250 kg Na ha^{-1} and four seed treatments on emergence, leaf development and yield. Fertiliser was applied in February but rain leached much of the Na out of the surface soil. Rubbed and graded seed, pre-soaked and air-dried seed, chitted seed with radicles just visible and seed with radicles up to 10 mm long were sown by hand in late April. Plants from chitted seed emerged in four days, and from pre-soaked or untreated seed in about ten days. Chitted seed gave the largest seedlings but differences between plants from chitted seed and pre-soaked seed progressivly decreased and at final harvest plants from pre-soaked seed gave most sugar, 9% more than from untreated seed. However, chitting seed provides the opportunity to discard the poor seeds and sowing of only the vigorous ones. Subsidiary experiments in a controlled environment room showed that choosing the best chitted seeds gave sufficient improvement in seedling density, growth and tolerance of soluble nutrients to justify further experiments. (Durrant)

Seed placement in the soil. In further tests with the Stanhay drill units modified by the National Institute of Agricultural Engineering, some drill arrangements gave fewer seedlings than the unmodified unit, but good emergence was given by sowing 4·5–5·0 cm deep, by the floating soil coverer, by the vee shaped press wheel directly on the seeds and by extra weight on the press wheel. These latter two treatments had also improved emergence in 1974, but other treatments which were beneficial in the one year were not in the other.

Soil temperature. Three soil pyramids 1 m high with 38° slopes facing north, south, east and west in the field showed that on average between 21 April and 21 May the 1600 h temperature 25 cm deep was 2·75°C warmer on the south facing slope than on the north facing slope. On the warmest sunny day during this period, 20 May, the differential was 11°C. During the night and for long periods on dull days there were no detectable differences in temperature between the four faces. Seedlings emerged quicker on the warmer slopes, and on the south facing slope became 84% heavier than on the north. The final number of seedlings was not affected by aspect.

https://doi.org/10.23637/ERADOC-1-132

Soil aggregate size. Soil was sieved into different aggregate sizes and equilibrated to 12% water content. Commercial raw or pelleted seed was sown 2·5 cm deep in boxes enclosed in a polythene bag. The growth room was programmed to provide a 15°C 8 h day and 5°C 16 h night. When emergence started boxes were uncovered. Seedling counts indicated an optimum aggregate size for maximum emergence which was slightly larger for pelleted than for raw seed. When aggregates were mixed in equal weights emergence was greater from mixtures of widely different sizes than from mixtures with a smaller range but this did not occur with pelleted seed. Interestingly, emergence was greater from the best mixture of aggregates than from the best single size.

Weed beet. In recent years new types of bolter have appeared in arable land cropped with sugar beet; they flower early enough to produce viable seed. Some have come from cross pollination with a dominant annual gene-carrying wild beet during seed production in southern Europe. These plants bolt readily in long days without vernalisation. Others appear to have been produced from existing varieties by natural selection. These early bolters seem to be under polygenic control and have a vernalisation requirement which is easily fulfilled after early sowings. Many indeterminate types also occur, possibly as hybrids between the above types and perhaps also with other beets including the English sugar-beet seed crops, root crop groundkeepers and the wild beet on the sea shores. Recent changes in sugar-beet growing practices towards closer rotations and less hand and machine hoeing seem to have favoured the establishment and spread of these weed beets which now infest an appreciable number of sugar-beet fields.

Two experiments were made to control them at Attleborough and Sedgeford, Norfolk. Both randomised replicated experiments tested cutting once or treatment by glove with 1 ml 10% glyphosate per bolter on 7–8 July. Seed was harvested on 28–29 August, threshed, cleaned and the weight and numbers recorded before testing three replicates of 100 seeds for germination in pleated filter paper. Results show that both methods of control greatly decreased seed production and the viability of the seed. Although glyphosate was more effective than cutting it damaged other crop plants nearby.

The sugar factory fieldmen each surveyed 10 contracts, indicating that about 1·4% of the beet crop area was infested with seedlings from seed shed at some time previously. Additionally some 20% of this year's area was infested at about 125–375 bolters ha^{-1}, presumably from seed sown this year, although only about a quarter of these fields flowered early enough to produce viable seed. Farmers with infested fields were advised to rogue these crops where possible.

Variety: environment interaction. In order to test for possible interactions between sugar beet varieties or breeding lines and the environment in which they are grown, 16 seed lots representing the diverse types currently in commercial use in Europe, were grown by members of the IIRB Genetics and Breeding Study Group at 21 sites within an area bounded by Sweden, Ireland, Spain, Greece and Poland. The study is to proceed for three years before final conclusions are drawn; this year differences in disease susceptibility and wilting were obvious. (Longden)

Sugar-beet manuring

The field experiments described here testing nitrogen and time of harvesting, phosphorus, potassium, sodium and soil structure, and long-term effects of liming were done in co-operation with staff of the British Sugar Corporation in 1974.

Nitrogen and time of harvesting. Three experiments were made on shallow calcareous soils in Lincolnshire to test whether time of harvesting affects the amount of nitrogen

https://doi.org/10.23637/ERADOC-1-132

needed for maximum sugar yield. Many growers and some advisers in that area believe that sugar-beet crops harvested late in the season need more nitrogen than is normally recommended. Thus on fields adequately fertilised with phosphorus, potassium and sodium, crops were given eight equal increments of nitrogen ranging from 0 to 290 kg N ha^{-1} as ammonium nitrate. Three blocks of eight plots were harvested at the end of September and three at the beginning of December.

Response to nitrogen was small on all three fields, probably due to the relatively dry weather conditions in the preceding winter. The crops were affected by virus yellows and increased in sugar yield by a smaller amount than usual between September and December. On average of the three experiments, about 80 kg N ha^{-1} was sufficient for maximum yield at either harvest but more work will be needed before this question is firmly resolved.

Phosphorus. Three further experiments were made to complete this investigation of response to 0, 14, 28, 56 and 112 kg P ha^{-1} on fields adequately fertilised with nitrogen, potassium and sodium. The fields were chosen so that the sodium bicarbonate-extractable soil P values were in the range 0–9 or 10–15 mg P $litre^{-1}$ (ADAS indices 0 and 1).

In the 20 experiments made between 1970 and 1974, the average yield without phosphorus fertiliser was 6·69 t ha^{-1} sugar and the increase from the optimum dressing was 0·46 t ha^{-1}; the average soil concentration wsa 12 mg P $litre^{-1}$. The fertiliser increased yield by 0·77 t ha^{-1} sugar on fields with 0–9 mg $litre^{-1}$ soil phosphorus, by 0·31 t ha^{-1} when soil phosphorus was 10–15 mg $litre^{-1}$ and had little effect on soils containing larger amounts.

A dressing of 27 kg P ha^{-1} was adequate for maximum yield on 19 of the 20 fields. When these fields and others were grouped in ADAS indices 0, 1, 2 and 3 respectively, 60, 30, 20 and 10 kg P ha^{-1} (approximately 1·2, 0·6, 0·4 and 0·2 cwt P_2O_5 $acre^{-1}$) were the most profitable dressings, taking into account the value of the increased sugar yield, the cost of the fertiliser and its residual value. These experiments provide evidence, however, that the fertiliser would be used more efficiently if fields containing 0–9 mg soil phosphorus were subdivided into those with 0–4·5 and those with 4·6–9·0 mg $litre^{-1}$and the groups given 80 and 40 kg P ha^{-1} respectively. These recommended amounts are substantially less than those used at present; they are adequate for the sugar beet but other crops in the rotation would need similar close examination to ensure maximum yield and maintain adequate soil reserves of phosphorus.

Potassium. Six more experiments were made to complete this investigation of response to 0, 42, 84, 168 and 336 kg K ha^{-1} with or without 377 kg ha^{-1} of agricultural salt (0 or 150 kg Na ha^{-1}) on fields adequately fertilised with nitrogen and phosphorus. The soils were chosen to contain little exchangeable potassium. In 20 experiments since 1970 sugar yield, on average, was greatest when 150 kg Na ha^{-1} plus 167 kg K was used, the fertiliser increasing yield by 0·71 t ha^{-1}. Response to this combination of K and Na fertilisers was 1·45, 0·57 and 0·22 t ha^{-1} sugar when the soil contained less than 60, 61–120 and more than 120 mg K $litre^{-1}$ respectively.

Results of earlier experiments indicated that response to even a large amount of K without Na would be less than to Na without K because usually there is insufficient rainfall in the spring for maximum response to K. In fact, 333 kg K ha^{-1} increased yield by about the same amount as Na, probably because most of these experiments were made in wetter-than-average springs.

The concentration of K and dried tops and roots in midsummer increased linearly with soils containing from 40 to 120 mg K $litre^{-1}$ but when there was more K in the soil the concentration of K in the plants did not increase further. By contrast, the concentration of Na in plants did not reach a similar plateau. Whole plants in midsummer contained

https://doi.org/10.23637/ERADOC-1-132

between 128 and 251 kg K ha^{-1} and 42 to 102 kg Na ha^{-1}, depending on the fertiliser treatment. Recovery of applied K varied from 90% when small amounts were used on fields containing least K to about 20% when large amounts were given on fields containing moderate amounts. Recovery of Na ranged from about 50 to 23%.

The comparison in the financial return from using K alone or K plus Na showed that Na was essential for maximum profit. On average, the most profitable dressing of K gave a return of £14 ha^{-1} whereas K plus Na gave up to £46 ha^{-1}. On fields with lesat K, the corresponding results were £50 and £115 ha^{-1} respectively. In relation to soil K, the most profitable application was 150 kg Na ha^{-1} plus about 150 kg K ha^{-1} on soils with 60 mg K litre^{-1} or less, and 150 kg Na ha^{-1} plus about 75 kg K ha^{-1} on most other soils.

Sodium, potassium and soil structure. The background and objects of these experiments have been described in *Rothamsted Report for 1973*, Part 1, 268–269. Four more were done on similar soils on the same farms as previously or nearby. Altogether, 12 experiments in eastern England since 1972 have tested all combinations of autumn and spring applications of 0, 150 and 300 kg Na ha^{-1} and 0, 83 and 333 kg K ha^{-1}. Fields with very fine sand, very fine sandy loam, sandy clay loam and clay loam textures were chosen. The effects of sodium on seedling emergence and growth from these soils were also determined in micro-plots and controlled environments.

Visual assessments of soil physical state following sodium application revealed no effect in the year sugar beet was grown nor in the following spring under cereals. Measurements of physical properties of soils treated with sodium suggested that applications of several times the recommended amounts of sodium fertiliser would not damage the soil. However, sodium fertiliser increased the osmotic suction of soil solution which, under some circumstances, e.g. dry springs or giving the fertiliser close to sowing, decreased germination and seedling growth. For this reason and *not* because it has a detrimental effect on soil physical condition, sodium fertiliser is best given in the autumn or some weeks before sowing.

Long-term effects of liming. Three of the experiments begun in 1968 (*Rothamsted Report for 1969*, Part 1, 327) were cropped with sugar beet for the third time. Half the plots had received one dressing of lime for the 1968 crop and the other half two applications, one for 1968 and a further equal amount for the 1971 crop. None was given for the 1974 crop since the pH of all plots was considered adequate for sugar beet. On plots given one application, yields were slightly but consistently greater from factory waste lime than from ground limestone or chalk. Where plots had received a second application, there was little more yield than from plots given one application and all the forms of lime gave similar yields.

Each year pH has been determined on all the plots. Generally, pH has not declined to the extent we envisaged, probably due to little leaching in several dry winters during the period 1968–74. This may also account for the small response to lime with resultant small differences between different forms. (Draycott)

Plant nutrients

Time of applying sodium. In recent years increasingly more sugar-beet growers have been interested in autumn application of P, K, Na and Mg fertilisers. To examine the effect of sodium on growth and yield, an experiment on Hackthorn field tested sodium at 0, 38, 75, 150 and 300 kg ha^{-1} as the chloride in autumn before ploughing or in spring during seedbed cultivations. Sowing was delayed by rain for two months after spring fertiliser application and even 300 kg ha^{-1} had no adverse effect on emergence. This

https://doi.org/10.23637/ERADOC-1-132

contrasts with previous experience where smaller plant populations resulted from large dressings of Na and K fertilisers given immediately before sowing. From emergence until mid-August, increasing amounts of sodium gave greater root and top yields and leaf area indices. Later in the season, treatment differences became smaller, possibly because the larger leaf areas made the plants more susceptible to water stress in the very dry summer. In last year's experiment, during less extreme water stress, sodium resulted in more photosynthesis.

Yields from autumn application were consistently less than from spring application. On average, sodium slightly increased sugar percentage as in previous experiments. Measurements of soil sodium showed that fertiliser applied in autumn had moved down the profile due to leaching in the wet autumn and winter, which may account for the poor response to autumn application. (Cormack)

Time and method of applying nitrogen. A new factorial experiment on Hackthorn field compared the effects of applying nitrogen fertiliser at the time of drilling between the rows using an attachment mounted on the drill, and broadcasting by hand prior to seed-bed preparation. Applications of 0, 62, 125 and 188 kg N ha^{-1} as ammonium nitrate were tested and the broadcast treatments applied on 27 March, one month before the crop was drilled.

The largest nitrogen dressing depressed emergence by 5% in broadcast plots and by 3% in plots where the fertiliser had been applied mechanically. On average, emergence was 4% greater on plots given fertiliser between the rows than on plots where it had been broadcast. Top soils (0–22 cm) and subsoils (22–61 cm) were sampled in early June and analysed for mineral nitrogen concentrations. Table 2 shows that the greatest amount of mineral N was in plots where the nitrogen fertiliser had been applied at the time of drilling. Only 65% of the applied N fertiliser was found in the broadcast plots, compared with 84% in plots which had received their fertiliser N one month later.

TABLE 2

Amounts of mineral nitrogen in the soil profile on 13 June

Fertiliser applied (kg N ha^{-1})	Broadcast one month before drilling 0–22 cm	Broadcast one month before drilling 22–61 cm	Machine-applied at drilling 0–22 cm	Machine-applied at drilling 22–61 cm
	(kg N ha^{-1})			
0	42	58	38	52
62	58	81	65	92
125	75	101	92	110
188	96	118	117	127

Twenty petioles from each plot were analysed for NO_3-N concentrations. The petioles of plants given 125 and 188 kg N ha^{-1}, particularly when broadcast, contained the highest NO_3-N concentration.

The results indicate that although fertiliser N leached during the spring in broadcast plots, the plants were as well supplied with nitrogen as those receiving nitrogen in late April. However, all petiole NO_3 concentrations were very low at the time of sampling, indicating some nitrogen deficiency. This may be explained by the poor physical condition of the soil preventing good root growth and nutrient uptake.

At harvest, root and sugar yields did not differ significantly for methods of application although the maximum sugar yield of 7·94 t ha^{-1} was obtained from the broadcast plots with a dressing of only 62 kg N ha^{-1}. Sugar percentage was depressed, on average, by 0·7% following large nitrogen dressings by either method of application. (Last and Webb)

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Manganese. Experiments tested manganese incorporated in the seed pellet or sprayed on the foliage of sugar beet in the Fenlands. In addition to the treatments tested last year (*Rothamsted Report for 1974*, Part 1, 62), $MnSO_4$ and manganous derivative of EDTA pelleted with the seed, and MnO pelleted with the seed and combined with one foliar spray in late June were also tested.

The Ely soil, pH 7·6, contained 0·3 mg Mn kg^{-1} exchangeable (Ex) Mn, 16·1 mg easily-reducible (E/R) Mn kg^{-1}. Peterborough soil 1·3 Ex Mn kg^{-1}, 9·0 mg E/R Mn kg^{-1} pH 5·7; Wissington soil 1·9 Ex Mn kg^{-1}, 29·7 E/R Mn kg^{-1}, pH 7·9. The plants from all experiments were sampled during May and July, before and after spraying.

Ely and Wissington experiments had 63 and 44% of plants with manganese deficiency symptoms respectively on untreated plots. At Ely, $MnSO_4$ in the seed pellet decreased incidence to 5% and MnO to 25% and at Wissington, both MnO and $MnSO_4$ decreased it to 25%. Two sprays of $MnSO_4$ eliminated all symptoms. Manganese frit was less effective and manganous derivative of EDTA had no effect. At Peterborough where the soil was slightly acid, no plants had manganese deficiency symptoms. Except for manganous derivative of EDTA which had no effect, all treatments increased the concentration of manganese in the plant but did not affect the plant dry weight during the year or the yield at harvest. At Ely, all treatments except manganous derivative of EDTA and one $MnSO_4$ spray increased the plant dry weight but at Wissington had no effect. Plots with and without MnO pelleted with the seed and sprayed once with $MnSO_4$ were similar on all experiments. Of all seed-pellet treatments, MnO and $MnSO_4$ increased the concentration of manganese in the plant most, the frit less and MnEDTA had no effect.

Adjacent to the experiment at Ely, 0, 1, 2 and 3 foliar sprays of $MnSO_4$, each equivalent to 4 kg Mn in 560 litres ha^{-1} given 14 days apart during late May and early July, were tested in factorial combination. Plant dry weights were determined monthly. All sprays increased the plant dry weight following their application and, thereafter, growth pareleled that of untreated plants. The third week of June was the most important time to spray the crop with manganese when it increased the yield of roots at harvest by 30%.

In laboratory determinations on healthy and deficient sugar-beet leaves of similar age from the field, photosynthetic activity and chlorophyll content increased with increasing manganese concentration up to 35 mg Mn kg^{-1} in the dried leaves. At concentrations greater than 35 mg Mn kg^{-1} there was no further increase in photosynthetic activity or chlorophyll content.

The experiment last year which compared $MnSO_4$ and manganous derivative of EDTA foliar-sprayed was repeated on West Row Fen where the soil with pH 7·5 contained 1·0 mg Ex Mn kg^{-1} and 13·2 mg E/R Mn kg^{-1}. The two compounds given as a foliar spray had similar effect. In June, 85% of plants given no manganese had symptoms. Manganese sprayed once decreased them to 50% and manganese sprayed twice to 10%. Manganese sprayed once had no effect but sprayed twice increased the final yield of roots by 3·4%.

The long-term experiment at Ely was cropped with wheat, var. Hybrid 46, and at Wissington, barley, var. Julia. Plants and soil were sampled throughout the growing period. Seedbed treatments applied to last year's sugar-beet crop had a small residual effect at the first sampling at Ely but none at later samplings or any samplings at Wissington.

Copper. The treatments tested on barley last year (*Rothamsted Report for 1974*, Part 1, 63) were applied to sugar beet on organic fen soil near Ely. The soil, pH 7·6, contained 2·8 mg EDTA-extractable Cu kg^{-1}. No treatment affected the yield at harvest which averaged 28·4 t ha^{-1} roots and 16·2% sugar. (Farley)

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Magnesium. Results of recent field experiments (see Paper No. 30) indicated that it might be possible to improve the availability of magnesium from the current commercial form of calcined magnesite. To investigate this, small samples of magnesite ore were calcined for up to 6 h at several temperatures between 500 and 1000°C, the most reactive oxide was produced by burning for 3 h at 700°C or 0·5 h at 800°C, i.e. the minimum time for complete conversion of the carbonate to the oxide. These forms contained nearly double the amount of readily-exchangeable magnesium than is present in the oxide used at present. Incomplete conversion or over-burning greatly affected reactivity. The analysis of the current commercial oxide showed that it contained a large proportion of overburnt, inert particles.

In three sugar-beet crops grown in alkaline soil in the glasshouse, the most reactive forms increased the magnesium concentration by 0·3% on average, whilst plants given the commercial oxide contained 0·2% more than plants given no magnesium fertiliser. The three crops removed about 70% of the applied magnesium from the reactive oxides but only 50% from the commercial form. The results of an incubation experiment suggested that burning at 700°C for 3 h gave a marginally more reactive oxide than the short burn at 800°C. (Durrant)

Irrigation

Irrigation and nitrogen. A further experiment tested six dressings up to 207 kg N ha^{-1}, on the sandy loam of Hackthorn field. On three of the six blocks, the crop was irrigated to limit the soil moisture deficit to 40 mm, and a record total of 224 mm of water was applied, given in July, August and early September. In common with all the experiments this year, sowing was delayed far beyond the optimum date by wet soil, but fertiliser had been applied at the usual time in readiness for mid-March sowing. There was thus the additional complication of movement of fertiliser nitrogen down the profile by the rainfall.

At harvest in October, the most striking result was the large response to irrigation, sugar yield being increased from 4·23 to 6·68 t ha^{-1}. This is by far the largest increase recorded during 11 years' experiments with irrigation at Broom's Barn. For the first time there was a large positive interaction between irrigation and nitrogen, the crop giving little response to nitrogen without irrigation and a large response with irrigation. Sugar yields were 4·00 t ha^{-1} without irrigation or nitrogen, 4·55 t ha^{-1} without irrigation but with nitrogen, 4·96 t ha^{-1} with irrigation but without nitrogen and 7·20 t ha^{-1} with both irrigation and nitrogen.

Weekly soil moisture measurements with the neutron probe showed that root growth was rapid compared with last year. In early May, water was extracted to 20 cm by bare-soil evaporation but the total deficit was small because there was negligible leaf cover. At the middle of May, rainfall returned the soil to field capacity, which is unusual. As in 1974, the deficit at the end of June was still only 25 mm, whereas the calculated potential deficit was 90 mm.

In early August, when a soil moisture deficit of 140 mm had been quickly established, the depth to which roots removed water was 125 cm. When maximum deficit was reached on 10 September, 210 mm of water had been removed to a depth of 160 cm which is usual on this soil in a dry year. (Last and Messem)

Time, rate and method of irrigation. This was the fifth year of experiments testing response by sugar beet to irrigation at different times and comparing a single application with several. For the first time, trickle irrigation to the soil and mist irrigation over the leaves were compared. Four treatments were as before (*Rothamsted Report for 1971*, Part 1, 287) but the other two, the single application in July or September, were replaced

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by tests of two eight-week mist irrigation periods, beginning in mid-June and in mid-August. As well as periodic determinations of yield and leaf area, plant water status measurements were made and these are described in the Report of the Botany Department, p. 44.

The soil moisture deficit, measured with a neutron probe, reached 200 mm on un-watered plots in September and, where water-use was monitored on plots irrigated frequently, seven applications totalling 266 mm were given. In August, when the deficit was 150 mm, root yield was increased 8% by giving 25 mm of water in June, the early period of mist increased it 35% and 178 mm of water gave 67% increase. At final harvest, the single application of 25 mm in June increased sugar yield by only 0·10 t ha^{-1} and 50 mm in August by 0·44 t ha^{-1}. Early and late mist treatments gave responses of 0·96 and 0·24 t ha^{-1} respectively, while the full trickle irrigation significantly improved yield by 1·42 t ha^{-1} or 25%. As in all previous years, there was no effect of applying 50 mm of water in September. Though close to the irrigation and nitrogen experiment described above, the site of this experiment had much more clay in the subsoil which accounted for the smaller yield response. (Durrant and Messem with Milford Botany Department.)

Green manuring

The object of this investigation and the treatments tested are described in *Rothamsted Report for 1973*, Part 1, 274. An experiment on Hackthorn was cropped with barley in 1974, when the average grain yield was 5·79 t ha^{-1} at 85% dry matter; green manures grown under the barley did not affect grain or straw yield.

The plots were split and given four amounts of nitrogen (0, 50, 100 and 150 kg ha^{-1}) before sowing sugar beet in 1975. The crop established poorly which resulted in a gappy stand and irregular yields at harvest. The cause was not identified with certainty but soil in the area worst affected had a relatively low pH of 6·1. Roots on some plants also had *Aphanomyces* damage.

Soil samples taken in April showed that the amount of mineral nitrogen in the top soil and subsoil was similar in all plots, averaging about 90 kg N ha^{-1}, and there were no consistent differences due to the green manures. At harvest, however, nitrogen fertiliser given to the sugar beet increased sugar yield much more than in recent years, probably due to the wet winter causing much leaching. Yields were least where neither green manure had been grown nor slow-release fertiliser given, and the crop responded greatly to fresh nitrogen fertiliser. Yields were largest after trefoil, fodder radish or slow-release nitrogen. (Last)

Plant spacing

Time of sowing and harvesting and plant density. The yields from the fourth experiment of this series (*Rothamsted Report for 1974*, Part 1, 64) testing three times of sowing and two times of harvesting at four plant densities are shown in Table 3.

TABLE 3

Sugar yield (t ha^{-1}) from different sowing and harvesting dates at four plant densities

	Harvest date									
	1 October Plants ('000 ha^{-1})					3 December Plants ('000 ha^{-1})				
Sowing date	50	75	100	125	Mean	50	75	100	125	Mean
21 April	7·22	7·80	7·79	8·19	7·75	8·72	9·08	9·71	9·53	9·26
30 April	6·43	7·33	7·41	7·31	7·12	8·07	8·75	9·03	9·05	8·73
12 May	5·68	6·34	6·49	6·43	6·24	6·45	6·88	7·55	7·85	7·18
Mean	6·44	7·16	7·23	7·31	7·04	7·75	8·24	8·76	8·81	8·39

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Early sowing gave the largest sugar yield. Sugar yield increased with plant density up to 100 000 plants ha^{-1} on all sowings and at both harvests. The average increase in sugar yield between the two harvests was 21% for the first two sowings and 15% for the third sowing.

Plants from the first and third sowings at all densities of stand were sampled and analysed for growth five times between 16 June and 15 September. The early sown crop produced the larger leaf area index (LAI) until early August, and maintained a larger growth rate to this date than the late sown crop. However, during August and September, the late sown crop partitioned more of its assimulate to top growth, and produced larger LAI's than the early sown crop. The densest stands also had the largest LAI's and growth rates until early August. These differences produced larger root weights from early sowings and dense stands which persisted to final yield. (Jaggard and Webb)

Soil structure

Damage to the soil during beet harvesting. In the third experiment of this series, treatments simulating damage to soil structure caused by sugar-beet harvesting in wet or moist soil were made on 22 December, the site was ploughed on 15 January, and sown with winter wheat var. Flinor on 4 March. At harvest, grain yield was decreased by an average of 0·2 t ha^{-1} to 4·20 t ha^{-1} by simulated harvesting under wet conditions; the removal of sugar-beet tops from the plots did not affect grain yield under any simulated harvesting regime; the nutrient value of the tops was balanced by the addition of fertiliser. Increasing the N fertiliser from 75 to 125 kg ha^{-1}, increased grain yield by 0·13 t ha^{-1} on the simulated moist and wet harvesting conditions. On the plots where harvesting in dry soil was simulated, nitrogen produced no yield increase. Simulated harvesting under wet conditions decreased straw yield, but the addition of sugar-beet tops and extra nitrogen fertiliser increased straw yields by 0·2 and 0·34 t ha^{-1} respectively.

Minimum cultivation. An experiment on sandy soil at Risby investigated the effect of minimum cultivation on the growth and yield of sugar beet. The cultivation treatments, split for three rates of nitrogen fertiliser, were (1) no cultivations; (2) two passes of a rigid-tined cultivator during November; (3) two passes of a rigid-tined cultivator during November followed by one pass of a dutch harrow during April; (4) mould-board plough during November followed by one pass of a dutch harrow during April. Treatments 1 and 2 were followed by an application of 2·8 litre paraquat in 560 litre water ha^{-1} on 8 March. The cultivation plots were split for N applications of 63, 125 and 188 kg ha^{-1} as 'Nitro-Chalk' on 4 March. Treatments 2, 3 and 4 were sown with a conventional drill on 1 May with var. Bush Mono at a seed spacing of 15 cm and treatment 1 with a drill modified to scrape trash to one side. All treatments were band sprayed with lenacil. The seedlings emerged by 14 May, when the soil had a significantly greater bulk density to a depth of 8 cm on the no cultivation treatment than on the remainder. Between 8 and 16 cm there were no significant bulk density differences between treatments. Significantly more seedlings emerged on the no cultivation treatment than on the remainder, because the drill used for this treatment delivered more seeds. During May the mould-board ploughed plots had significantly more *Polygonum persicaria* and less *Stellaria media* and *Poa annua* seedlings than the others. Nitrogen fertiliser had no significant effect on beet or weed seedling populations.

At harvest in late October the no-cultivation treatment significantly decreased root yields, but increased sugar content, giving sugar yields significantly decreased by 1·4–2·1 t ha^{-1}. The rigid-tined cultivation treatments yielded 0·4 t ha^{-1} of sugar more but not significantly more than the mould-board ploughed treatment. Sugar yield on the culti-

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vated and ploughed treatments did not respond to more than 63 kg N ha^{-1}, whereas the no cultivation treatment responded to 188 kg N ha^{-1}.

Heavy rainfall delayed sowing the crop by nearly two months when much of the nitrogen was leached down the soil profile. The more dense surface soil of the no cultivation treatment, coupled with very rapid drying of the soil following seedling establishment, probably retarded root extension of the beet plants, resulting in nitrogen starvation and poorer yields. (Jaggard)

Growth control chemicals

Sugar beet were sprayed once only, at three-week intervals from 13 June to 15 August with 1·1 kg a.i. of three chemical growth regulators in 520 litres water ha^{-1}: 'AC 99524', 'AC 92803' and 'AC 99850'. 'AC 99524' applied in July and early August significantly increased root yield compared with unsprayed by a mean of 4·2 t ha^{-1}, decreased sugar concentration by a mean of 1·0%, and significantly increased sugar yield by 0·4 t ha^{-1} to a mean of 5·56 t ha^{-1}. This chemical also significantly increased the concentration of sodium impurities but decreased alpha-amino nitrogen impurities in the roots. Unlike experience in previous years, the chemical did not make the crowns of the plants more fibrous. The other two chemicals, 'AC 92803' and 'AC 99850' had no significant effect on yield or impurity concentrations.

'AC 99524' and 'AC 92803' were also tested at 70 and 700 g a.i. as solutions (370 litre ha^{-1}) trickled into the furrow with the seed. All except 'AC 92803' (70 g) decreased seedling numbers by 25%. At harvest 'AC 92803' (700 g) significantly decreased sugar yield from 4·78 to 3·57 t ha^{-1}. 'AC 99524' at 70 and 700 g a.i. ha^{-1} elongated the crowns by 3·2 and 7·5 cm respectively. 'AC 92893' had no effect at the smaller dose but the large dose elongated crowns by up to 2·5 cm. (Winder, Dunning and Jaggard)

Weed control

Stubble cultivations. This experiment, started in 1973, was of the same design as that described in *Rothamsted Report for 1974*, Part 1, 66–67. Herbicide applied to Maris Nimrod wheat in 1973, and Proctor barley in 1974, had no significant effect on their grain or straw yields. Use of a herbicide (MCPA/dicamba/mecoprop mixture) on the wheat crop in 1973 reduced weed cover from 22 to 6% of the land area on non-cultivated plots by early November; weeds were almost absent on the remaining treatments. In 1974, weed populations were much smaller and there were no significant treatment differences. In the sugar-beet crop in 1975 the use of a herbicide in the two previous cereal crops reduced weed numbers from an average of 103 to 49 m^{-2} in May, but cultivating or spraying the stubbles in the two previous years had no significant effect on weed numbers. Both pyrazon and phenmedipham gave good control of weeds except *Rumex crispus*, which proved troublesome on plots which had no herbicides or stubble cultivations during the two previous years. The use of herbicides in previous crops increased sugar-beet yield where no stubble cultivations were carried out and where the stubbles were sprayed with paraquat. (Jaggard)

Cereal and rotation experiments

Fertilisers on rotation crops. This was the eleventh year of the experiment testing fertilisers applied to a rotation of sugar-beet, winter wheat and barley. (For the fertiliser dressings, see *Rothamsted Report for 1965*, 279, Table 7.)

This experiment is not irrigated and yields were much depressed by lack of water. Table 4 shows that mean yield of grain was only about 3·5 t ha^{-1}; sugar yield at 3·7 t ha^{-1}

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was the smallest since the experiment started in 1965. Response to nitrogen fertiliser by barley was particularly large and the crop may have responded to more than N_2 (100 kg N ha^{-1}). As in 1974, the wheat needed N_1 (75 kg N ha^{-1}) but sugar beet needed very little nitrogen fertiliser for maximum yield. As before, there was no response to the other nutrients by the cereals but the K and Na fertilisers increased sugar yield by about 1·2 t ha^{-1}. (Durrant)

TABLE 4

Yield response of crops to fertiliser in the eleventh year of the rotation experiment

	Wheat grain (t ha^{-1} at 85% DM)	Barley grain (t ha^{-1} at 85% DM)	Sugar (t ha^{-1})
Mean yield	3·71	3·44	3·74
Response to:			
N_1	+2·14	+2·78	+0·37
$N_2 - N_1$	−0·46	+0·99	−0·28
P_1	+0·19	+0·16	−0·10
$P_2 - P_1$	+0·30	+0·16	+0·02
K_1	+0·29	+0·03	+0·84
$K_2 - K_1$	−0·26	−0·23	+0·52
Na	+0·16	−0·07	+1·16
FYM	+0·53	+0·45	+0·60
Compound$_1$	+2·35	+2·24	+1·49
Compound$_2$ − Compound$_1$	−0·28	+0·79	−0·11

Frequency of beet and barley

This was the eleventh year of the experiment testing yields in five contrasting crop rotations (for details see *Rothamsted Report for 1966*, 248). Because of the late sowing, poor emergence, infection with virus yellows and the drought, sugar yield of 4·8 t ha^{-1} was again well below the ten year mean (6·5 t ha^{-1}) for the trial.

Beet following the two year grass ley gave the largest sugar yield (5·3 t ha^{-1}). Sugar yields were similar (4·9 t ha^{-1}) from the continuous beet and after two barleys, and least (4·4 t ha^{-1}) following five barleys or potatoes and beans.

Barley grain yields (3·7 t ha^{-1} at 85% dry matter) were similar following beet or one cereal crop, and least after three cereals (2·7 t ha^{-1} at 85% dry matter). The beans, potatoes and leys all suffered badly from the drought and yielded little. (Webb)

Nitrogen and fumigation. The experiment on Brome Pin (*Rothamsted Report for 1974*, Part 1, 67) testing the residual effects of soil fumigation with 'D-D' and form of nitrogen fertiliser on nematodes and crop yields, was cropped with spring barley in 1975. Fumigation treatments were applied on 19 September 1974.

Plots were sampled to 20 cm depth on 21 February 1975 for determination of nematode numbers. All genera of plant parasitic nematodes (except *Paratylenchus* sp.) were more numerous in both fumigated and unfumigated plots than in January 1974. In plots fumigated every year, numbers of all plant parasitic genera (except *Paratylenchus*) remained at less than 10% of those in unfumigated plots; in plots fumigated only before sugar beet, numbers of plant parasites were still considerably less than in untreated plots but had increased greatly since 1974 (Table 5).

Plants sampled in early May showed that fumigation and nitrogen increased plant weights when applied in the absence of the other. Applying both, increased plant weights further and at this stage of growth the greatest yields were obtained from plots where the nitrogen had been applied as ammonium sulphate and fumigated every year.

https://doi.org/10.23637/ERADOC-1-132

TABLE 5

Control of nematodes by soil fumigation in the nitrogen and fumigation experiment

Nematode	Nematode numbers per litre of soil: Unfumigated	Fumigated every year	Fumigated before sugar beet only
Tylenchus	513	38	175
Tylenchorhynchus	538	38	138
Heterodera larvae	925	0	238
Pratylenchus	2563	238	1450
Paratylenchus	425	100	363
Rhabditida	9738	1625	8150
Trichodorus	63	0	0
Mononchidae	238	0	88
Other Dorylaimida	1138	563	650

Top soils (0–22 cm) and subsoils (22–61 cm) were also sampled on the same date. Fumigation increased soil mineral nitrogen slightly and there were no consistent differences due to differing forms of nitrogen fertiliser. Most mineral nitrogen was in the subsoil on all plots.

Analysis of the barley plants for nitrate–nitrogen showed little effect of either fumigation treatment, but plants which received their nitrogen fertiliser in the nitrate form contained the highest nitrate concentration.

Table 6 shows that, at final harvest, grain and straw yields were greatly increased by fumigating the plots in the autumn of 1974, whether or not they were given nitrogen fertiliser. Yields were the same from both forms of fertiliser and there was a large response to nitrogen. The yields obtained from plots fumigated once every three years indicated some residual effect of treatment in 1973 on barley yields in 1975. (Cooke and Last)

TABLE 6

Grain and straw yields at 85% DM in the nitrogen and fumigation experiment

	N dressing (kg ha^{-1})	Fumigation treatment: None	Every year	Before sugar beet only
Yield of grain (t ha^{-1})	0	1·51	2·78	1·62
	125 (NH_4)	3·85	4·61	4·45
	125 (NO_3)	3·68	4·63	4·21
Yield of straw (t ha^{-1})	0	1·19	2·45	1·20
	125 (NH_4)	4·30	5·69	4·90
	125 (NO_3)	3·93	5·72	4·91

Fertilising the subsoil. Wet soil conditions in the autumn of 1974 allowed no opportunity to use the heavy machinery for injection of more liquid fertiliser on this experiment (*Rothamsted Report for 1974*, Part 1, 68). The area was cropped with winter wheat, var. Flinor, drilled in the early spring of 1975. The average grain yield at 85% dry matter was 4·18 t ha^{-1}. None of the residual subsoil or fertiliser treatments affected yield significantly.

Soil conditions were much better in autumn 1975 and fertiliser was re-injected on the same plots and at the same rates as before. It will be cropped with barley in 1976. (Draycott)

Magnesium and boron. This experiment (*Rothamsted Report for 1974*, Part 1, 63) was sown with barley, var. Proctor. Soil samples taken in spring for analysis contained similar amounts of Mg and B to those taken last year. None of the treatments affected the yield which averaged 3·56 t ha^{-1} grain and 3·58 t ha^{-1} straw at 85% dry matter.

https://doi.org/10.23637/ERADOC-1-132

Phosphorus and potassium. This experiment (*Rothamsted Report for 1973*, Part 1, 279) which compares phosphorus and potassium fertilisers applied annually with the same total amount once in the rotation, was sown with barley, var. Proctor. Potassium given this year increased grain yield but not straw, whereas that given in 1973 had no effect. Neither form of phosphorus affected the yield.

Analysis of top and subsoil showed that most of the applied phosphorus was in the top soil and none in the subsoil. Superphosphate increased the sodium bicarbonate soluble P more than did Gafsa phosphate. Potassium increased the exchangeable K in both top and subsoils. (Farley)

Fungicides on barley

Fungicides were tested at the recommended rate on spring barley for the control of mildew, which was severe on Proctor, moderately severe on Julia and slight on Maris Mink.

Ethirimol seed dressing improved the vigour and height of Julia and Maris Mink and, like the tridemorph spray, controlled mildew well and improved 1000 grain weight and yield of Julia from 4·42 t ha^{-1} untreated to 5·28 t ha^{-1} with ethirimol and 5·05 t ha^{-1} with tridemorph, and of Maris Mink from 4·37 to 5·69 and 5·29 t ha^{-1} respectively. Neither ethirimol nor tridemorph alone improved the yield of Proctor, but together they increased the yield from 5·05 to 5·59 t ha^{-1}. (Webb)

Broom's Barn Farm

Changes in soil analysis 1960–75. Soil from Little Lane, White Patch, New Piece and Windbreak fields were sampled and analysed in 1975 to complete the project started in 1973 (*Rothamsted Report for 1973*, Part 1, 280; *for 1974*, Part 1, 69) investigating the changes in nutrient status of the soil at Broom's Barn. Table 7 compares the analysis of top soil sampled in 1960 and 1975. Generally, these fields are naturally calcareous and are not limed except the soil of the Dullingham Series on New Piece. The grass and clover grown in 1973 gave a small increase in organic matter on White Patch but otherwise amounts decreased slightly. Except on Windbreak, more P and K was given in fertiliser in the 15 years than removed by crops, so amounts found in the soil have increased. On Little Lane, the excess P and K was 157 and 130 kg ha^{-1} respectively, and this gave 11 and 66 mg litre^{-1} more P and K in the top soil. This field was also given Mg fertiliser recently which increased the amount in the exchangeable fraction. (Durrant)

TABLE 7

Changes in soil analysis between 1960 and 1975 at Broom's Barn

Field	pH (in water)		Organic matter (%)		$NaHCO_3$-soluble P (mg l^{-1})		NH_4^+-exchangeable K (mg l^{-1})		NH_4^+-exchangeable Mg (mg l^{-1})	
	1960	1975	1960	1975	1960	1975	1960	1975	1960	1975
Little Lane	8·2	7·8	2·38	2·19	35·0	45·7	156	222	55	67
White Patch	8·1	8·1	2·24	2·28	23·1	26·0	165	203	49	47
New Piece	7·8	7·3	1·89	1·79	19·8	25·9	127	164	50	54
Windbreak	7·6	7·5	2·06	1·98	42·2	46·3	164	150	71	58

Cropping. The very wet autumn delayed ploughing which was finished in very poor conditions during January. After negligible frost the soil was in a sodden state that made spring work difficult. The winter wheats looked poor after the wet autumn but the grass ley, undersown in the spring of 1974, was well forward. One barley field was drilled in

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late February but, due to excessive rain, no more was sown until the third week of April. The summer turned very hot and dry and all these late crops suffered from drought.

Flint Ridge and Little Lane fields were subsoiled this year working both ways at 55 cm deep and 90 cm between tines. The Holt was cultivated both ways at 38 cm deep. Dunholme and parts of Flint Ridge and New Piece were limed and Flint Ridge was dressed with FYM. Trees were planted at the east end of the Windbreak and around the new farm building.

Cereals. The wheats were given only 50 kg P and 50 kg K ha^{-1} in the autumn except the second wheat crop on The Holt, which had 23 kg N ha^{-1} in the seedbed as well. Since the spring was very wet an aerial top dressing of 65 kg N ha^{-1} was applied on 26 March and a further 47 kg N ha^{-1} from the ground on 7 May. Most of the wheats were sprayed with carbendazim to control disease and all were sprayed with pirimicarb in early July to control aphids.

Seed of var. Proctor, ethirimol treated, was sown during late February but the Maris Mink barley was not sown until the third week of April. All the cereals were sprayed with an appropriate herbicide.

Harvest started on 6 August and continued uninterrupted through good weather until 19 August when rain delayed cutting for three days. The remainder was quickly finished between 23 and 26 August. Grain moistures ranged from 11 to 17%.

Beans. Maris Bead tic beans were sown during a short dry spell on 21 March but rain delayed spraying with simazine until 21 April. Bees again worked the crop and no aphid control was necessary. The beans were harvested on 16 August at 14% moisture.

TABLE 8

Grain yields at 85% DM

	ha		Yield t ha^{-1}
Brome Pin	9·77	Proctor barley (undersown)	3·73
New Piece	5·22	Maris Mink barley	3·93
Little Lane	7·98	Maris Mink barley	3·25
	0·80	Flinor wheat (experiments)	4·14
Bullrush	4·61	Champlein wheat (seed)	5·55
Dunholme	8·97	Maris Huntsman wheat	5·76
The Holt	4·49	Maris Huntsman wheat	4·77
Windbreak	1·19	Barley	3·51
Marl Pit	5·16	Maris Bead Beans	2·17

Fodder crops. The ryegrass ley on Flint Ridge was given a compound fertiliser in the spring and cut for silage during the last week of May. It was immediately top dressed with N, given 50 mm of irrigation and cut for hay on 4 July.

The undersown ley on Brome Pin established under the barley during the spring, but died off in the very dry summer. It was re-sown after harvest and has established satisfactorily during the autumn.

Sugar beet. The fertiliser ploughed down in autumn 1974 on both White Patch and Hackthorn fields supplied P_2O_5 55; K_2O 150; Na 137; Mg 62 kg ha^{-1}. The N fertiliser at 118 kg ha^{-1} was broadcast between the rows at drilling. As with other spring work, the rain delayed the first sowing until 21 April, but by the end of the month most of the required area was drilled leaving only the late drilled trials to be finished by mid-May. All the crops were sown with pelleted monogerm seed except a few plots in variety trials; 1·2 ha were sown at 8·7 cm seed spacing or less, 1·2 ha at between 8·7 cm and 15 cm, and the remaining 10·8 ha at 15 cm or more.

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Most of the crop was band sprayed with pyrazon at drilling, or overall sprayed on non-standard row widths. All subsequent weed control was by hoeing. Also at drilling two thirds of the crop was treated with aldicarb and later sprayed twice with insecticide to control aphids. The remaining third was generally sprayed three times with insecticide. The spray programme started in early June and continued until mid-July resulting in a reasonable control of yellows. Late in the summer the whole crop became heavily infected with powdery mildew. Irrigation (150 mm) was given in three equal applications, starting early in July.

Harvesting started on 14 October in good conditions which persisted until mid-November when rain made the land wet, but all beet were lifted by 9 December. Deliveries to the factory finished on 19 December. Yields averaged 33·25 t ha^{-1} of clean roots at an average sugar content of 16·5% ranging from 14·8 to 17·7%. Mean dirt and top tares were 89·4 and 41·5 kg t^{-1}. The country's average yield this year was 25·16 t ha^{-1} of roots at 16·05% sugar.

Livestock. In October 1974, 91 cross bred heifers were bought and fattened in the yards on *ad lib* silage, barley straw and restricted concentrate ration of 50% rolled barley and 50% beet pulp. A small amount of the concentrate was fed most of the time and only increased to finish fattening the smaller animals for sale during April and May.

The yards were re-stocked with 82 cross bred heifers in October. (Golding)

Staff and visiting workers

Numerous groups and personalities visited the Station, notably Dr. Gavin Strang, Parliamentary Secretary, Ministry of Agriculture and the Eastern Regional Panel. An ARC Visiting Group reviewed the activities of the Station in May. The Association of Applied Biologists came for their Annual General Meeting, at which R. Hull gave the Presidential Address.

R. A. Dunning, R. Hull, P. C. Longden attended the 38th Winter Congress of the International Institute of Sugar Beet Research in Brussels; R. A. Dunning and G. D. Heathcote attended the Pests and Diseases Study Group meetings at Wageningen, Holland and Leuven, Belgium, and P. C. Longden the Genetics and Breeding Study Group meeting at Carlow, Ireland. R. A. Dunning attended an OILB meeting in Utrecht. R. Hull chaired a session at the Weed Control Conference in Paris and attended the Summer Congress in Switzerland. He organised an Advanced Course on Sugar Beet at the Mediterranean Institute for Advanced Agronomic Studies at Zaragoza, Spain, sponsored by the Organisation for European Co-operation and Development, at which A. P. Draycott, R. A. Dunning and P. C. Longden gave courses of lectures. At the invitation of Hellenic Sugar Industry he visited Greece to discuss sugar beet growing there and the research programme. Six members of staff contributed to the 8th British Insecticide and Fungicide Conference at Brighton. Sandwich course students, T. S. Coupe from Bath University, M. S. Haigh, Trent Polytechnic and D. J. Potter, Ewell County Technical College, worked with us for six months.

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Theses

1 Baker, A. N. (1975) Studies on some soil-inhabiting arthropod fauna in the sugar-beet crop. Ph.D. Thesis. University of Bath.

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2 DURRANT, M. J. (1975) Factors affecting the response to potassium and sodium fertilisers by sugar beet. M.Phil. Thesis. University of Reading.

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4 BYFORD, W. J. (1975) Fungal diseases of sugar beet in England and the prospects for the use of fungicides. *Proceedings 8th British Insecticide and Fungicide Conference*, 465–471.

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