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R. Hull

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DUNHOLME FIELD STATION

R. HULL

G. H. Winder was appointed in June, and G. D. Heathcote in October to replace A. J. Gibbs. C. E. Cornford resigned in July.

In January R. Hull and A. J. Gibbs attended the meeting of the Virus Committee of the International Institute of Sugar Beet Research in Holland, and Gibbs attended the 22nd Congress in Brussels in February.

In October preliminary work began at Broom's Barn Farm, Barrow, West Suffolk, to which the work at present done at Dunholme will be transferred when buildings are ready.

Crops at Dunholme suffered from drought this summer. A few experiments at outside centres failed because of drought but, where soil water was adequate, exceptionally heavy yields were recorded, e.g., 30 tons/acre of roots (5½ tons/acre of sugar) at Pondersbridge, and 28 tons/acre of roots (4½ tons/acre of sugar) at Holbeach.

The British Sugar Corporation co-operated in and gave invaluable help with 118 field experiments in commercial sugar-beet root and seed crops and in mangold crops, as well as with regular surveys of diseases, aphids and other pests.

Incidence of sugar-beet yellows

The fine, dry spring and summer favoured aphids and the spread of yellows in sugar-beet crops. Few green aphids and virus-infected plants survived from the previous year, but infestations multiplied rapidly in May. An early migration of *Aphis fabae* from spindle led to large and general infestations of beet crops.

The scheme, developed during the previous 2 years, whereby farmers were warned of the need to spray proved valuable for checking the aphid attack. The agricultural staff of the British Sugar Corporation counted aphids in sugar-beet fields each day from early May until mid-July, and bulletins summarising the results were circulated each week. Growers were advised to spray their beet crops with systemic insecticide when average infestation for a district approached 0.25 green aphids/plant, or when *A. fabae* threatened to damage the foliage. The first warnings went out in mid-May, and by the end of May most growers in the eastern counties had been advised to spray. By the middle of June, growers in the early infested areas were advised to spray again. The average number of green aphids/plant in unsprayed crops in all areas reached 200 in early July and black aphids 2,000. In Yorkshire and Scotland most crops were sprayed in late June or early July. After declining in August and September, aphid infestations again increased on sugar beet in October and doubtless contributed to the large migration and egg deposition of *Myzus persicae* on *Prunus* spp. and *A. fabae* on Spindle.

The efficacy with which spraying controlled aphids varied greatly from field to field; spraying wilted crops at low gallonage in

hot weather was often ineffective. The results with different insecticides varied more than in previous years. Both green and black aphids quickly reinfested sprayed crops and some growers sprayed three or four times. Spraying ceased towards the end of July although infestations were still large in some areas and persisted into August. Of the total crop of 409,000 acres, 381,000 acres were sprayed once and about 190,000 acres more than once.

On average 15% of sugar-beet plants had yellows at the end of August. This was the same incidence as in 1958; it was less than half that of 1957 and 1949, two years of comparable aphid infestations when crops were not sprayed. The rate of spread of yellows was less than was expected from the aphid infestation, possibly because aphids were killed on early infected plants, which prevented the numbers of viruliferous *alatae* increasing quickly. In some crops the appearance of yellows symptoms was delayed by drought, which restricted leaf growth.

Twenty field experiments assessed the efficacy of spraying crops with systemic insecticides at the time recommended to growers. Yields were determined on fifteen, and on four the yield increase during October and November was assessed. Where *A. fabae* were numerous the beet showed an immediate response to spraying, and a greater yield increase resulted than was expected from controlling yellows alone. On a Sussex experiment spraying increased the yield of sugar from 38 to 74 cwt./acre. On all experiments harvested the average sugar yield response to an early spray was 26%, to a late spray 23% and to two sprays 28%. The increase came largely from increase in root yield, but sugar percentage also increased by up to 1.6; spraying appreciably improved juice purity. Yields increased during the autumn by 15% on unsprayed and by 16% on sprayed plots. (Hull.)

Sources of viruliferous aphids

To study the control of aphids in mangold clamps, a part of each of 21 mangold crops was sprayed with demeton-methyl about 2 weeks before harvesting and the sprayed mangolds were clamped separately from the unsprayed. Leaf samples of the unsprayed plants had few aphids on them in the autumn and, apart from one trial, leaves from the sprayed plants had none. Nearly all the aphids were *Myzus* spp., almost exclusively *M. persicae*; *Rhopalosiphoninus staphyleae* was not recorded. Aphids occurred on the crowns of unsprayed mangolds only when topping was incomplete. In the spring of 1959 half the clamps of unsprayed mangolds contained aphids. Only one of the clamps of sprayed mangolds had *M. persicae*, whereas five clamps of unsprayed mangolds were infested. *R. staphyleae* were more numerous in the clamps of unsprayed than of sprayed mangolds, except at one site where both clamps were heavily infested. Aphid infestation on the plants in trials repeated in the autumn of 1959 was much higher than in 1958.

During April, 17 of 23 mangold clamps examined in Lincolnshire had aphids, when *M. ascalonicus* was recorded 4, *M. persicae* 12 and *R. staphyleae* 9 times.

Aphids were found in 48 of 105 samples of weeds from beet-

growing areas examined between mid-March and early May. The weeds were of many species, but mainly *Senecio vulgaris*, *Stellaria media* and *Plantago* spp. *Myzus ascalonicus* was recorded 24 times, *M. persicae* 21, *Macrosiphium* spp. 10 and other species 21. None of the beet plants to which many of these aphids were transferred developed severe (necrotic) yellows. (Dunning.)

Yellows and mosaic viruses were more common in the wild beet on the East Anglian coast than elsewhere, whereas rust (*Uromyces betae*) was more common on beet on western coasts. Wild beet growing on foreshores of the Shotley peninsula of Suffolk were examined at regular intervals throughout the spring of 1959 and overwintering *M. persicae* were found at only one of eight sites. At this site aphids were found only on wild beet some distance above spring-tide level.

In the glasshouse, aphids preferred sugar beet watered or sprayed with tap water to those watered or sprayed with sea-water. The effect of watering with sea-water on aphid preference took 2-3 weeks to develop. Salt solution gave results similar to those obtained with sea-water. (Gibbs.)

Tolerant varieties

Some of the varieties selected at Dunholme for tolerance of yellows yielded more than commercial varieties where yellows, aphid infestation and drought were severe. At Sprowston the varieties were tested on sprayed and unsprayed plots, which had respectively about 10% and 100% of plants with yellows when harvested. On the unsprayed plots 8 of 11 outpollinated progenies exceeded the yield of the commercial varieties, but only 2 did so on the sprayed plots; the unsprayed progenies gave 106% and the sprayed 91% of the sugar yield of the commercial varieties with the corresponding spray treatment. At Erwarton (Ipswich), where aphids, yellows and drought were severe, 8 out-pollinated progenies gave on average 101% of the yield of the commercial varieties, but at Kirton (Spalding), where the crop had more soil water and was relatively free from yellows and downy mildew, they yielded only 95% as much as commercial varieties. Inbred lines 58/11/21, 58/45/694 and 58/103/233 always outyielded commercial varieties where yellows was severe, especially on the artificially infected plots at Dunholme, but gave less than the commercial varieties on the sprayed plots at Sprowston and at Kirton. Lines 58/19/303, 58/20/30, 58/93/1, 58/103/233 and 58/337/4S consistently outyielded the commercial varieties at all centres where tested. Hybrids between the older selected tolerant lines outyielded the commercial varieties by 30% on average at Erwarton and Dunholme, but on average they yielded only 97% as much as the commercial varieties at Spalding, and on the sprayed plots at Sprowston.

Out-pollinated seed produced from roots selected from plots of varieties Bush E and Sharpes E, infected either with severe (N) or mild (M) isolates of yellows virus, or with both isolates (NM), was sown at Dunholme and the plants artificially infected with severe yellows virus. The average yields (as percentage of commercial varieties) for the M, N and NM selections from Bush were respectively

90, 96 and 120%; for the selections from Sharpes they were 93, 103 and 101%.

The growth on the field of a hybrid (Q) between the tolerant varieties Q1S/1 and A7S/1 was compared with that of variety Sharpes E when healthy and when infected with yellows. By mid-June the dry-matter yield of Q was depressed 40% by yellows and that of Sharpes E 57%. By the final sampling in November, Q plants infected as seedlings yielded 58% more dry matter than infected Sharpes E, and the dry-matter yield of the healthy Q plants was 92% of that of healthy Sharpes E. Fresh weights of roots in November were identical for the two varieties when healthy, but the sugar content of Q was 0.6% higher than Sharpes E. When infected early, Q yielded 68% more sugar/root than infected Sharpes E. A late infection gave yields intermediate between the early infected and uninfected plants.

Leaf growth was restricted by drought throughout the summer as well as by yellows. The healthy Q plants had more leaf area than Sharpes E at first, but less in the autumn. At first the infected plants of both varieties had similar leaf areas but less than the healthy plants; in the autumn the infected Q plants had more than infected Sharpes E. A greater proportion of the total dry matter of healthy Sharpes E was in the crowns and petioles than of infected Sharpes E or of infected or healthy Q. Leaves of infected plants had a greater percentage dry matter than healthy leaves, but petioles and crown had less, as did the roots at first, but by November all roots had about 23½% dry matter.

The net assimilation rate of both varieties when healthy was similar at first, but Q had a rate half that of Sharpes E during the autumn. Q had a greater net assimilation rate than Sharpes E when infected; this difference persisted till harvest and largely accounts for the difference in yield of the varieties. In the field trials at Ipswich and Sprowston this variety gave 115, and 108% of the sugar yield of commercial varieties. (Hull.)

Insecticides

During the heavy aphid attacks of 1959 the insecticides listed in Table 1 were tested in the field for their control of aphids and yellows incidence. All insecticides, except endrin and ethion, significantly decreased the number of both *Aphis fabae* and *Myzus persicae*. At Dunholme "Rogor", and especially fluoroacetamide and "P.P. 175", killed *A. fabae* slower than the other products. At Dunholme the number of syrphid larvae was decreased by all insecticides used except endrin.

All the insecticides except "Ethion" and endrin decreased yellows incidence and increased yield. Direct damage by aphids, especially *A. fabae*, was severe at all sites except Ely, and the yield increases from spraying resulted from control of both aphid damage and yellows.

The systemic insecticides "Disyston" and "Thimet" were tested in two root crops as seed treatments, broadcast or "in-the-row", soil treatments, top dressings and various combinations of these in comparison with one, or two, sprays of demeton-methyl.

TABLE 1
Control of aphids and yellows by insecticides, 1959

Site	Chettisham, Ely	Nettleham, Lincoln	Dunholme Lodge, Lincoln	Dunholme Airfield, Lincoln			
Date of treatment ...	5 June	12 June	26 June	22 June			
Volume of spray used	40 g./a.	50 g./a.	55 g./a.	20 g./a.			
Treatment and amount applied per acre	% Yellows § 2 Sept.	% Yellows § 27 July	Sugar * yield	% Yellows § 6 Aug.	Sugar * yield	% Yellows § 5 Aug.	Sugar * yield
Demeton-methyl 50%, 12 fl. oz.	19	31	161	17	122	39	243
" Bayer 4536 " 50%, 6 fl. oz.	15	31	166			43	240
" Rogor " 32%, 16 fl. oz.	17	31	159			49	229
Fluoroacetamide 15%, 20 fl. oz.	21	34	137			45 †	208 †
" N.P.H. 52 " 50%, 12 oz.	18	31	146			46	206
" N.P.H. 60 " 20%, 16 fl. oz.	17					45	204
" P.P. 175 " 15%, 60 fl. oz.	19					45	233
" Phosdrin " 99%, 2 fl. oz.				23	108		
Endrin 20%, 30 fl. oz.				41	82		
" Ethion " 20%, 32 oz.		47	86				
Mean control	24	48	100	37	100	72	100
Least significant differ- ence (P = 0.05) ...	5.6	7.4	25.4	14.6	Insig.	11.7	51.4
Control yield (lb. of sugar/acre)			3310		4513		1246

§ Angular transformation.
* Sugar yield as percentage of the control.
† Fluoroacetamide applied at 27 fl. oz./acre.

All seedbed treatments depressed seedling emergence, even "Thimet" seed dressing at the very low rate of 1 oz. active ingredient/acre and, in one trial, "Thimet" broadcast at 1½ lb. active ingredient/acre. Every "Thimet" or "Disyston" treatment decreased aphid infestations, especially of *A. fabae*, and also decreased the incidence of yellows at first; at the end of August, however, none affected the incidence more than did two demeton-methyl sprays. In one trial the best results were obtained by top-dressing the plants with granular "Thimet" or "Disyston" (1½ lb. and 3 lb. active ingredient/acre respectively) after singling. These treatments applied early (26 May), after a seed-dressing of the same material, controlled aphids for some time and decreased yellows incidence as much as did two demeton-methyl sprays applied on 10 June and 24 June. (Dunning and Winder.)

"Thimet" and "Disyston" were tested as seed and/or soil treatments with stecklings sown on 1 August 1958. Plant populations were lowered by the "Disyston" seed dressing (4 oz. active/10 lb. seed) and more seriously by the "Thimet" seed-dressing (2 oz. active/10 lb. seed), whereas the soil treatments (1½ lb. active/acre) had little effect. These tonic effects were probably increased by flooding of the plots 10 days after drilling. Seed treatment gave the best initial kill of aphids, but seed-dressing plus soil treatment controlled aphids for longer periods, and this was reflected in the incidence of yellows. Untreated plots had 5.6% of plants with yellows in

November and 15.1% in May; seed dressings, 3.8% and 10.3%; soil treatments, 3.0% and 8.2%; seed-dressings and soil treatments, 1.6% and 3.3% respectively. (Dunning and Dunham.)

Seed crops

Sugar-beet and mangold seed crops surveyed in June by the National Agricultural Advisory Service and British Sugar Corporation steckling inspectors contained few plants with yellows, as expected from the previous autumn's inspection of steckling beds. Most sugar-beet seed crops and two-thirds of the mangold seed crops had less than 5% infected plants. Downy mildew was more prevalent than usual; 3.4% of sugar-beet seed plants and 0.5% of mangold plants were infected. Sugar-beet seed crops raised under a mustard crop were particularly susceptible. The 1959 stecklings suffered severely from prolonged drought, and virus yellows was difficult to distinguish from yellowing from other causes. Only an occasional sugar-beet steckling bed was discarded because more than 1% of plants had yellows. All but 3% of mangold steckling beds had fewer than 1% of infected plants. (Dunham and Hull.)

So far, most stecklings with cover-crops for protection against yellows have been sown in spring, but in 1958 cover-crops for summer-sown stecklings were tested. Cover-crops sown between the beet rows were only half as effective as those sown in the row in keeping plants free of *A. fabae*. Buckwheat, linseed, mustard, Nida turnip, rape and maize had a satisfactory growth habit, and of these, linseed suppressed the steckling growth least. (Dunning and Dunham.)

Chemical defoliant sprayed on ripening sugar-beet seed plants killed the leaves quickly, but the main stem remained too wet for successful combine-harvesting and started to grow again after 3 weeks. Seed plants cut in the normal way dried in a few days. (Dunham.)

Seed treatment trials

Blackleg was unusually prevalent in 1959, the result of seed infection with *Pleospora betae* in the wet harvest of 1958. The organo mercury dust-dressings in commercial use failed to control blackleg, and a few severe attacks were traced to inadequately treated seed.

Sixteen insecticidal and fungicidal treatments were tested in unreplicated strips on sites in each of 18 factory areas, using rubbed and graded seed which had 56% of clusters infected with *P. betae*. As in previous years, the best fungicide was EMP steep, which increased seedling stand by 40%; "Panogen" and an experimental liquid fungicide gave 24% and 28% increases respectively. Dried seed sprayed with 6% v/w of a 0.2% solution of EMP gave slightly fewer seedlings than untreated. Dieldrin and γ -BHC dusted on to EMP-steeped seed gave more seedlings/oz. than EMP steep alone, but heptachlor gave fewer. All three insecticides gave slightly thinner final plants stands. The insecticidal effect of four commercial organo-mercury/insecticide dusts was influenced by the concentration and efficiency of the fungicides. The dressing containing γ -BHC

N

gave fewer seedlings/oz. of seed than those containing dieldrin or heptachlor, but a thicker final plant stand. Liquid insecticide treatments were tested for the first time. (Byford and Dunning.)

Steeping in EMP trebled, and "Ceresan" dust doubled the seedlings produced by seed with 60% of the clusters infected with *P. betae*. "Panogen", a 2% organo-mercury dust, and this dust with griseofulvin, were better than "Ceresan" but less effective than EMP steep. Griseofulvin dust alone increased seedlings by 18%.

Sprayed seed gave poor results in the factory trials, probably because it was damaged by mercury when packed, possibly slightly damp, in polythene bags. Seedling emergence in the glasshouse from seed stored for 3 months in a polythene bag after being sprayed with 8% of 0.3% EMP solution, was only a tenth that of the seed stored in a hessian bag. However, diploid and polyploid seed treated at normal rates with "Panogen", "Ceresan" and "Ceresan W" germinated normally after storage for 3 months in polythene and hessian bags.

Batches of Sharpes E seed from seed crops with 9-91% of clusters infected with *P. betae* were sown in the field either untreated or steeped in EMP. Steeping increased emergence by from 11 to 163%; the larger increases were with the most heavily infected samples. Untreated samples heavily infected with *P. betae* gave fewer seedlings in the field than expected from laboratory germination tests. The laboratory germination, which ranged from 43 to 92%, was not related either to *P. betae* infection or cluster size. The conflicting results reported last year were obtained with ungraded seed from the plots of a seed production experiment. (Byford.)

Other diseases

During June and July, 39 crops were reported with an apparently new disease, which has been named neck rot. The root rots and becomes hollow immediately below the crown, which often shrinks, furrows or splits. As the rot extends the plants wilt and die. The trouble is thought to be caused by weakly parasitic fungi (*P. betae*, *Fusarium* sp.) invading tissue injured earlier, possibly by frost, and was more prevalent in some beet varieties than in others.

In five seed crops grown without transplanting the number of plants with downy mildew varied little between November and March, but increased during April in three. In one the increase was delayed until May when, despite dry weather, 10% of plants had mildew.

Two Bordeaux-mixture sprays applied to a root crop between brairding and singling decreased downy mildew incidence in early June from 1 to 0.3%, and incidence did not increase later. Three "Dithane" sprays applied to a root crop in June and early July did not influence downy mildew, which increased from 0.5 to 1.8% affected plants during August. (Byford.)

Docking disorder was not seen during 1959. At Docking commercial Wyoming bentonite (40 tons/acre) increased yield of sugar beet roots by 10%, whereas local clay soil (120 tons/acre) only slightly increased yield. On microplots of Docking soil at Rothamsted, Wyoming bentonite increased yield by 33%, sterilised loam increased

yield by 53%, and 400 lb./acre of D.D. soil fumigant increased yield by 29%. (Gibbs.)

Several sugar-beet crops were reported as severely damaged by herbicidal sprays. Some were affected by drift while spraying nearby cereals, others from spraying sugar beet with machines used previously to kill weeds. Glasshouse plants showed abnormalities when sprayed with MCPB at a dilution of $1 : 2 \times 10^7$. Most sprays tested severely distorted sugar beet at dilutions between $1 : 2 \times 10^4$ – 10^5 . MCPA, CMPP, MCPB produced the most leaf crinkle and 2 : 4 : 5-T the most contortion. Individual plants varied greatly in their susceptibility. (Wolfe.)

SUGAR-BEET MANURING

The main work was again a series of field trials conducted in co-operation with the field staffs of the British Sugar Corporation, but results of the 1959 experiments are not yet known. This report gives the 1958 results.

NPK-dung trials

Fifteen 3^3 factorial experiments tested 0.6, 1.2 and 1.8 cwt. N/acre as sulphate of ammonia; 0, 0.5 and 1.0 cwt. P_2O_5 /acre as superphosphate and 0.8, 1.6 and 2.4 cwt. K_2O /acre as muriate of potash. Ten of these tested the mineral fertilisers with and without dung.

Without dung, the most profitable average dressings were 1.2 cwt. N/acre, 1.0 cwt. P_2O_5 /acre and 0.8 cwt. K_2O /acre. 1.8 cwt. N/acre gave less sugar than 1.2 cwt./acre. The response to phosphate was higher than normal because of two exceptionally responsive fields at Ipswich and Selby.

With dung, the most profitable dressing of nitrogen was 0.6 cwt. N/acre. Higher rates of nitrogen were usually deleterious. Even with dung, 0.5 cwt. P_2O_5 /acre could be justified, but dung provided all the potash needed by the crop. The Ipswich experiment was exceptional because N up to 1.8 cwt./acre increased yield whether dung was applied or not.

Average responses were higher than in 1957, perhaps because the winter of 1957–58 was wetter than that of 1956–57. However, virus yellows was also less prevalent in 1958 than in 1957.

Ploughing-down and P and K trials

Ten experiments compared seedbed application of 1.0 cwt. P_2O_5 /acre as superphosphate and 1.5 cwt. K_2O /acre as muriate of potash with the same fertilisers applied in the previous autumn and ploughed in.

Ploughing-down of P and K in the autumn was less effective than broadcasting in the seedbed, lowering yield by an average of 1.7 cwt./acre sugar. At Kelham and Colwick the yield lost from ploughing-down was 7.2 and 5.0 cwt./acre sugar respectively. At Allscott, Poppleton and Wisington ploughing-down was slightly beneficial, but it is not known why these fields differ from the rest. These results are similar to 1957.

Comparison of forms of nitrogen fertilisers

Eight experiments compared the effect of 0.6 cwt./acre N applied as sulphate of ammonia, calcium nitrate or urea in the seedbed or as top-dressing at the time of the last hoeing. An additional 0.6 cwt. N/acre applied either in the seedbed or as a top-dressing was also tested.

These experiments ended after 3 years. Calcium nitrate and urea were as effective as sulphate of ammonia in promoting sugar production, but calcium nitrate was more efficient than sulphate of ammonia and urea for producing tops. Splitting a dressing of 1.2 cwt. N/acre between the seedbed and the time of the last hoeing was no more effective than putting all in the seedbed, even in the wet spring of 1958. Delaying half the nitrogen did not lower the yield of sugar compared with putting all in the seedbed.

The average of all experiments showed that 0.6 cwt. N/acre in the seedbed was the most profitable fertiliser dressing. The increased yield of tops given by 1.2 cwt. N/acre may, however, justify the higher rate of nitrogen on farms where tops are fed to stock.

Growth analysis of sugar beet receiving different levels of nitrogen fertiliser

In 1959, plots of sugar beet given different quantities of N up to 1.8 cwt./acre in the seedbed, or partly in the seedbed and part as a top-dressing, were sampled seven times during the growing season to obtain information on the effect of N on growth. At the end of the season N did not significantly increase sugar yield, probably because drought was the limiting factor. In the early harvests, before water limited growth, significant responses in leaf area and dry-matter accumulation were obtained up to 1.2 cwt. N/acre. Even then there was no additional advantage in applying 1.8 cwt. N/acre and on 2 July this treatment caused a barely significant depression of leaf area and dry matter compared with 1.2 cwt. N/acre. (Adams.)

The effect of salt and potash on sugar beet on the Lincolnshire limestone soils

Six 2² factorial experiments on the Jurassic Limestone soils of Lincoln Edge tested the effect on sugar beet of 1.5 cwt. K₂O/acre as muriate of potash and its chemical equivalent of salt (1 $\frac{3}{4}$ cwt./acre). All plots received 1.0 cwt. N/acre as sulphate of ammonia and 0.5 cwt. P₂O₅/acre as superphosphate. On average, salt and potash increased yield by 3.7 and 3.3 cwt. sugar/acre respectively. Both fertilisers together increased sugar by 5.8 cwt./acre. Response to salt was smaller in 1959 than in the wet summer of 1958. These results do not support the idea that salt acts because it can hold soil moisture in a dry spell. (Adams.)