

SCOTTISH SOCIETY FOR RESEARCH
IN PLANT-BREEDING

REPORT

BY THE

DIRECTORS

TO THE

ANNUAL GENERAL MEETING

17th July 1941



1941

SCOTTISH SOCIETY FOR RESEARCH IN
PLANT-BREEDING,
REPORT.

THE Directors of the Scottish Society for Research in Plant-Breeding have pleasure in submitting the Twentieth Annual Report to members of the Society.

That the Society's work is regarded as of national importance is indicated by the fact that all members of the scientific staff were placed in reserved categories by the Agricultural Research Council in 1940. As none of the staff has therefore been required for military service, the Society was able to carry on its work without much diminution of its activities.

An outstanding event in the activities of the year was the putting into commerce of the Society's new potato, Craigs Defiance. Applications for seed were invited from members of the Society, and there was a keen demand for it, the total amount applied for being much in excess of the quantity available—viz., 25 tons. It was decided that allocation should be made in lots of one ton each, and that in view of the large number of applications the lots should be allocated among members by ballot. The successful applicants were required to give an undertaking that they would grow their consignment of Craigs Defiance in one lot, and, if possible, under conditions whereby a Stock Seed Certificate may be obtained from the Department of Agriculture for Scotland.

Small quantities of elite stocks of Early Miller and Bell oats and about $\frac{1}{4}$ acre of stock seed Alness potatoes were

grown in 1940, and these were purchased by members of the Society.

It will be recalled that in last year's report reference was made to the transfer of the Society's sub-station from Ainville, Kirknewton, to Boghall Experimental Farm, Lothianburn. The re-erection of the greenhouses and other buildings there was completed in time to carry out the season's programme of potato-breeding experiments. There is reason to believe that the change to Boghall will prove to be advantageous for potato-breeding investigations. Acknowledgment is made of the helpful assistance rendered by members of the College staff at Boghall.

It is with regret that the Directors have to report that a fire occurred at Craigs House on the morning of 24th January last. The fire appears to have originated somewhere in the region near the central heating boiler in the extension at the west end of the house. When discovered it had obtained a firm hold of this portion of the building, and before the flames were brought under control the room used as an office by the Director of Research and the cloakroom above the central heating installation were gutted. The library of books was accommodated in the Director's room, and, with the exception of a few books which were being used by members of the staff in other buildings, the collection was completely destroyed. Fortunately none of the Society's financial books or important experimental material was lost. It has not been possible to ascertain the cause of the fire. The damage was covered by insurance.

Staff.

Two members of the staff have applied to the Agricultural Research Council for de-reservation. Mr John M. Main, B.Sc., applied for de-reservation in June 1940, and his request was granted by the Agricultural Research Council. He resigned his appointment as assistant for cytological work as at 7th

September 1940 on his receiving an appointment with the West of Scotland Agricultural College, Glasgow. Miss Margaret F. Torrance, B.Sc., was appointed to succeed Mr Main.

In May 1941 Mr Charles A. Lyall, B.Sc., assistant in the cereal-breeding section, applied for de-reservation. This application was supported by the Agricultural Research Council, and Mr Lyall left on 10th May to train for a commission in H.M. Forces.

Financial.

In previous years the financial statement relating to the Virus Disease Investigation of Potatoes was shown separately, as a special grant was received for this work. For the year 1940-41, however, the grant from the Department of Agriculture for Scotland to the Society for virus disease investigations was not differentiated, and was combined with the grant which the Society received towards maintenance expenditure. On this occasion, therefore, the accounts have all been included in one Abstract, and the assets and liabilities in one Balance-sheet.

The ordinary accounts, as audited at 31st March 1941, show that the Society's funds now stand at £46,927, of which sum about £2582 represents assets previously included in the Virus Disease Investigation Scheme Accounts. If allowance is made for the inclusion of the latter sum, the increase in the funds this year amounts to about £273.

The Society's income was considerably augmented by the additional returns from sales of produce. The prices obtained for produce were higher than in the previous year, and the marketing of the new potato Craigs Defiance helped to increase the total. As compared with the sales in the preceding year, those of this year showed an increase of about £570. It is gratifying to note that in these difficult times membership subscriptions again show a slight increase. The total amount of grant received from the Department of Agriculture for

Scotland for the year was £4232, 15s. 7d., as compared with total grants of £4274 in 1939-40.

The total ordinary expenditure shows an increase of about £393, additional expenses being incurred on salary increments according to scale, labour, and by renewals. The last item includes the cost of purchasing a new tractor to replace the old one, which had been in use since 1926.

No capital expenditure was incurred during the year.

“Dr Wilson” Memorial Fund.

This fund now amounts to £326, 6s. 8d. No payments were made from the fund during the year.

Membership.

The Directors regret to report that in the past year nine members died and two resigned. It is pleasing to note, however, that six new members were enrolled during the year ended 31st March 1941. At 31st March the membership consisted of 134 life members and 126 annual members (25 at the 5s. rate and 101 at the 10s. rate of subscription). A list of members appears on pages 29 to 36 hereof.

Donors of £10 and over are entitled to become life members without further payment. Donors of £5 may become members of the Society by payment of an annual subscription of 5s., and others by payment of an annual subscription of 10s.

Election of Directors.

In accordance with the rules of the Society, the six senior Directors retire at this time. Their names are as follows :—

- A. Y. ALLISON, Turnhouse Farm, Corstorphine.
- W. J. CAMPBELL, 61 Fountainhall Road, Edinburgh.
- ROBERT HOWIE, Grange, Kirkcaldy.
- WILLIAM KAY, 19 South St David Street, Edinburgh.
- ROBERT L. SCARLETT, Sweethope, Musselburgh.
- PROFESSOR ERNEST SHEARER, Agricultural Department, The University, Edinburgh.

To fill the vacancies thus created, the Directors recommend the election of the following :—

Major R. F. BREBNER, The Leuchold, Dalmeny House, Edinburgh.
 THOMAS HOGG, 21 Hope Street, Glasgow.
 MATTHEW MATHER, Brackenrig, Barnnton Avenue, Edinburgh, 4.
 GEORGE G. MERCER, C.B.E., Southfield, Dalkeith.
 ANDREW M. RIDDEL (W. Drummond & Sons, Ltd.), Stirling.
 Sir JOSHUA ROSS-TAYLOR, Mungoswalls, Duns.

JOHN STIRTON,
Secretary.

SEEDS FOR DISPOSAL.

It is expected that several quarters of élite stocks of seed of Early Miller and Bell oats, grown at the Station, will be available for disposal early in 1942.

A few tons of Craigs Defiance seed potatoes from stock grown at Gibston, Huntly, and about 1⁰ ton of The Alness seed potatoes from stock grown at Boghall, Midlothian, should also be available for disposal.

There may also be small quantities of seed of the following grasses for disposal: two new strains of perennial ryegrass, one of hay timothy, and a re-selected strain of cocksfoot, Cc 180.

[ABSTRACT OF ACCOUNTS.]

ABSTRACT OF

For the year ended

INCOME.

Interest Received		£1,154 14 9
Recoverable Income Tax		441 13 8
		£1,596 8 5
Sales—		
Ordinary, including Stocks on Hand	£798 7 11	
Extraordinary—		
Craigs Defiance Potato Account	187 3 10	
		985 11 9
Subscriptions—Annual		54 5 0
<i>Note.</i> —Annual Subscriptions amounting to £6, 15s. are in arrear.		
Donations—Sums under £10		6 0 0
	Total Ordinary Income	£2,642 5 2
Grant received from Department of Agriculture for Scotland for the year 1940-41		4,232 15 7
Capital Income—		
Donation	£10 0 0	
Interest on Donations and Life Membership Subscriptions (£1418, os. 4d. at 3½ per cent, less Income Tax)	£34 17 7	
Recoverable Income Tax (estimated)	14 15 0	
	49 12 7	
		59 12 7
	Total Income	£6,934 13 4
Funds at 1st April 1940		46,770 16 8
		£53,705 10 0

ACCOUNTS.

31st March 1941.

EXPENDITURE.

Salaries—		
Officers, including Sub-Station		£3,425 7 6
Secretary and Office		286 2 0
		£3,711 9 6
Superannuation Contribution		314 12 6
Labour		978 7 9
National Insurance		29 6 8½
Seeds and Roots		48 17 4
Manures		155 0 1
Working Expenses, including renewals of Implements and Tools		348 1 9
Laboratory Expenses		10 0 5
Library Expenses		45 13 2
Rates and Insurances		46 11 3
Office Expenses		80 0 7
Heating, Lighting, and Cleaning		59 0 9
Travelling Expenses		55 17 11
Property Repairs		28 1 11
Locality Trials		4 6 10
Sub-Station Maintenance Expenses		329 4 0
Virus Investigation Maintenance Expenses		242 17 2
	Total Ordinary Expenditure	£6,487 9 7½
Depreciation on Temporary Buildings, Implements, &c.		290 19 1
	Total Expenditure	£6,778 8 8½
Funds at 31st March 1941, per Balance-sheet		46,927 1 3½
		£53,705 10 0

BALANCE-

As at 31st

LIABILITIES.

I. Accounts Outstanding, due by Society	£523 6 4
II. Subscriptions paid in advance	4 0 0
III. Funds at 31st March 1941	46,927 1 3½

£47,454 7 7½

DR WILSON MEMORIAL

Value at 31st March 1941.	Funds at 31st March 1941—	
£210 0 0	£200 3½ per cent War Stock, 1929-47	£176 5 0
	Sum in Bank on Deposit Receipt	143 10 2
	Sum in Bank on Current Account	6 11 6
		<hr/> £326 6 8

EDINBURGH, 12th May 1941.—The undersigned, having had access to all the Accounts, and verified the same with the Accounts and Vouchers relating thereto, now
16 ALVA STREET.

SHEET.

March 1941.

ASSETS.

I. Houses and Lands, at Cost, less Depreciation	£8,675 2 7
II. Virus Scheme Buildings, &c., at Cost, less Depreciation—	
Craigs House	£1,948 5 0
Boghall Sub-Station	634 6 2
	<hr/> 2,582 11 2
III. Greenhouse, Hut, and Frames at Sub-Station, at Cost, less Depreciation	108 5 7
IV. Implements and Tools, at Cost, less Depreciation	564 11 0
V. Laboratory Apparatus, at Cost, less Depreciation	83 13 3
VI. Office Furniture and Fittings, at Cost, less Depreciation	80 14 4
VII. Stocks on Hand, as valued by Directors	159 5 0
VIII. Accounts Outstanding, due to Society	711 14 5
IX. Income Tax Recoverable	456 8 8
X. Investments, at Cost:—	
Value at 31st March 1941.	
1. £14,130, os. 9d. 3½ per cent War Stock, 1929-47	£12,530 0 0
2. £14,000 4 per cent Funding Stock, 1960-90	10,045 0 0
3. £16,900 3½ per cent Conversion Stock	11,140 3 6
	<hr/> 33,715 3 6
£48,317 0 0	
XI. Cash Balances—	
In Bank on Current Account	£304 11 8
On Hand	12 6 5½
	<hr/> 316 18 1½
	<hr/> £47,454 7 7½

FUND ACCOUNT.

Funds at 1st April 1940	£319 6 8
Interest for year	7 0 0
	<hr/> £326 6 8

Books and Accounts of the Society, and having examined the foregoing Statements of signs the same as found to be correct, duly vouched, and in accordance with law.

ROBERT MACDONALD, C.A., *Public Auditor.*

DISTRIBUTION OF MEMBERSHIP

As at 31st March 1941.

Aberdeen	13	Linlithgow	6
Angus	17	Midlothian	48
Argyll	6	Moray	1
Ayr	16	Nairn	—
Banff	1	Orkney	2
Berwick	13	Peebles	3
Bute	1	Perth	13
Caithness	—	Renfrew	5
Clackmannan	—	Ross and Cromarty	6
Dumbarton	4	Roxburgh	8
Dumfries	8	Selkirk	1
East Lothian	25	Stirling	4
Fife	13	Sutherland	—
Inverness	2	Wigtown	2
Kincardine	1	England	9
Kinross	1	Abroad	3
Kirkcudbright	4		—
Lanark	24		<u>260</u>

ESTABLISHMENT FOR 1940-41.

BOARD OF DIRECTORS.

Trustees.

H.M. SECRETARY OF STATE FOR SCOTLAND, Scottish Office,
St Andrew's House, Edinburgh, 1.

JOHN FINLAYSON M'GILL, Kyle Street, Ayr.
SIR JOHN H. MILNE HOME, Irvine House, Canonbie.

Ordinary Directors.

1938.

A. V. ALLISON, Turnhouse Farm,
Corstorphine.
W. J. CAMPBELL, 61 Fountainhall
Road, Edinburgh.
ROBERT HOWIE, The Grange, Kirk-
caldy.
WILLIAM KAY, 19 South St David
Street, Edinburgh.
ROBERT L. SCARLETT, Sweethope,
Musselburgh.
Professor ERNEST SHEARER, Agri-
cultural Department, The Univer-
sity, Edinburgh.

1939.

WILLIAM ALLISON, Almond Hill,
Kirkliston.

IAN C. MENZIES, W.S., 22 Rutland
Street, Edinburgh.
FRANK G. MILNE (John Milne &
Sons), Montrose.
Professor Sir WILLIAM WRIGHT
SMITH, Inverleith House, Edin-
burgh.
JAMES WITHER, Awhirk, Stranraer.

1940.

DAVID BELL, 15 Coburg Street,
Leith.
JAMES H. ELDER, B.Sc., Cregganore,
North Berwick.
WM. HUGH HAMILTON, W.S.,
Cairns, Kirknewton.
A. D. C. MAIN, B.Sc., Windyedge,
Perth.
FRED MILLS (Roughhead & Park, Ltd.),
Haddington.
JAMES PATON, Kirkness, Glencaig.

Directors Co-opted.

Major R. F. BREBNER, The Leuchold, Dalmeny House, Edinburgh.
THOMAS HOGG, 21 Hope Street, Glasgow.
GEORGE G. MERCER, C.B.E., Southfield, Dalkeith.

Directors nominated by the Department of Agriculture for Scotland.

Sir PATRICK R. LAIRD, C.B.,
J. M. CAIE, M.A., B.L., B.Sc., } St Andrew's House, Edinburgh, 1.
T. ANDERSON, M.A., B.Sc., }
ALEXANDER M'CALLUM, M.A., LL.B., 78 Craiglea Drive, Edinburgh.

Chairman of Directors—Sir JOHN H. MILNE HOME, Irvine House, Canonbie.

Vice-Chairman—.....

Director of Research—WILLIAM ROBB, N.D.A., F.R.S.E., Craigs House,
Corstorphine.

Chief Assistant—JAMES W. GREGOR, Ph.D., D.Sc., F.L.S., Craigs House,
Corstorphine.

Assistants—V. M'M. DAVEY, B.Sc., Ph.D., CHARLES A. LYALL, B.Sc.,
and MARGARET F. TORRANCE, B.Sc., Craigs House, Corstorphine.

Assistant, Potato-Breeding Sub-Station—WILLIAM BLACK, B.Sc., Ph.D.,
Boghall.

Assistants, Virus Disease Scheme—GEORGE COCKERHAM, B.Sc., Ph.D., and
COLIN H. CADMAN, B.Sc., Ph.D., Craigs House, Corstorphine.

Temporary Assistant—J. M. S. LANG, B.S.A., Craigs House, Corstorphine.

Secretary—JOHN STIRTON, 8 Eglinton Crescent, Edinburgh.

COMMITTEES.

RESEARCH.

Fred Mills, *Convener*.
 William Allison.
 T. Anderson.

 David Bell.
 Major R. F. Brebner.
 J. M. Caie.
 W. J. Campbell.
 James H. Elder.
 Wm. Hugh Hamilton.
 Thomas Hogg.
 Sir John H. Milne Home.
 Robert Howie.

William Kay.

 Sir Patrick R. Laird.
 Alexander M'Callum.
 J. F. M'Gill.
 A. D. C. Main.
 George G. Mercer.
 Frank G. Milne.
 James Paton.
 Robert L. Scarlett.
 Professor E. Shearer.
 Professor Sir William Wright Smith.
 James Wither.

MANAGEMENT.

William Allison, *Convener*.
 A. Y. Allison.

 David Bell.
 Major R. F. Brebner.
 J. M. Caie.
 Thomas Hogg.
 Sir John H. Milne Home.
 Robert Howie.

.....
 Alexander M'Callum.
 A. D. C. Main.
 Ian C. Menzies.
 George G. Mercer.
 Fred Mills.
 James Paton.
 James Wither.

FINANCE.

Alexander M'Callum, *Convener*.
 A. Y. Allison.
 William Allison.

 J. M. Caie.
 W. J. Campbell.
 Wm. Hugh Hamilton.
 Sir John H. Milne Home.

Sir Patrick R. Laird.
 Ian C. Menzies.
 George G. Mercer.
 Fred Mills.
 Robert L. Scarlett.
 Professor E. Shearer.
 Professor Sir William Wright Smith.

R E P O R T

BY

DIRECTOR OF RESEARCH

I. Research Programme.

Up to 31st March none of the members of the Society's scientific staff was required for military service, and it was therefore possible to carry out the various plant-breeding projects which were included in the programme of work for the year. In view of the importance of seed production, some reduction has been made in the amount of trial-plot work so that as much land as possible may be utilised for the production of crops for seed and for food. The Agricultural Research Council has suggested that Plant-Breeding Stations should make special efforts to save as large a stock of vegetable seeds as possible. Consideration has therefore been given to the problem of raising seeds of certain vegetable plants of which there is a chance, if weather conditions are favourable, of obtaining fully developed and ripe seed at Corstorphine. Attempts will be made in 1941 to seed peas, carrots, leeks, and probably onions. It is hoped to make some additions to this list in 1942.

The transfer of the Society's buildings from Ainville to Boghall was completed in time for last season's potato-breeding experiments to be carried out on the usual scale. From this year's experience, conditions at the new sub-station seem likely to prove suitable for the various potato-breeding investigations.

A review of the work for the year ended 31st March 1941 follows.

GRAIN CROPS.

WILLIAM ROBB, *Director of Research.*
CHARLES A. LYALL, B.Sc., *Assistant.*

Oats.

Resistance to Lodging.—The breeding of shorter-strawed oats seems to offer possibilities of obtaining an increased degree of resistance to lodging, and from crosses which were made a few years ago between various selected pairs of varieties there was a large amount of material for selection. Many selections obtained from crosses with the Semi-dwarf oat were again grown in 1940, and these contained promising but still unfixed types. There were also promising types in hybrid progenies obtained from Early Miller, Elder, and Marvellous crosses.

Early-ripening Types for Upland Areas.—One fixed but un-named selection from Potato oat \times Yielder has been under trial for a few years in various parts of Scotland, and results obtained indicate that this oat is worthy of more extended trials, particularly in the more upland areas where an early-ripening variety with upstanding straw is required. This selection has white, medium-sized, well-filled grain, and its early-ripening character is a point in its favour. In the present national emergency further field trials at different centres must be deferred until a more suitable time, but a small stock of this new selection will be grown on so that seed may be available for trials when required.

A group of early-ripening fixed hybrid selections was included in the small trial plots for observation and comparison. Further observations will be made on them at Corstorphine, and field trials of the best of them in upland areas will be made when more favourable opportunities occur.

Resistance to prompt Germination at Harvest Time.—The produce of the resistant selections taken in 1939 from the hybrids of Elder \times wild oat (*Avena fatua*) were tested for germination immediately after harvest in 1940. The selections have reached the fifth-hybrid generation, but fixed resistant types have not yet been obtained. The wild oat has also been crossed with another but larger-grained cultivated variety

with the object of securing a resistant type with larger grain than that of the Elder cross referred to above.

An extensive collection of named varieties of oats was grown in small plots to maintain representative samples, and pure stocks of Early Miller and Bell oats were grown for seed.

Barley.

A start has been made with the collecting of six-row barleys from various parts of the world. It is intended to carry out experiments in crossing some of these, and a number of crosses was made during the season.

Attention continues to be paid to the production of an improved Scots Common type of barley, and further crosses with this end in view were made during 1940. Efforts are also being made to secure an improved Scots Bere and a good quality naked barley.

Colchicine Treatment.—In previous reports (1939, 1940) reference has been made to attempts to induce polyploidy in barley by treatment with colchicine. The treatment produced a number of plants with sectors showing the characteristic malformations indicative of an increased chromosome number. These were evidently mixoploids, but the ears produced by these abnormal sectors were normal in appearance, and when the grain was germinated chromosome counts showed that all the seedlings were normal diploids. Indeed, although various workers have been successful in inducing polyploidy in a range of plants by treatment with colchicine, considerable difficulties have been encountered in the application of the treatment to cereals.

In 1940 the colchicine work was undertaken on a far larger scale than previously. Approximately 1000 barley seedlings were given individual treatment with colchicine. Various forms of treatment were used, as well as a range of different strengths of colchicine solution. Time of treatment varies from 20 minutes to 24 hours. About 10 per cent of the plants survived treatments and produced some 300 tillers with ears. Of these 300 ears about 25 per cent showed some abnormality, and 8 per cent showed marked abnormality such as: pronounced twisting of the rachis, fusion of parts, proliferation, formation of secondary spikes, &c.

Grain from the ears of treated plants has been sown in the greenhouse at intervals since December 1940. Root-tip chromosome counts have been made on germination. Examination of the material is still proceeding, but to date some 200 seedlings have been examined, and of these twelve have proved to be tetraploids, three plants have an unbalanced number of chromosomes, and ten others are abnormal, but await a final chromosome count. The tetraploids and other plants with an abnormal number of chromosomes have resulted from identical treatments with colchicine.

Wheat.

Work with wheat has proceeded along similar lines to those followed during the last few years. The collection of foreign spring wheats, which are claimed to be resistant to Loose Smut, has had additions made to it. Testing the resistance of these wheats to infection by Loose Smut under Scottish conditions continues. A more precise and certain method of inoculation with the smut spores has been adopted. Crossing with the resistant varieties has continued, and a considerable number of crosses was made during the season. A hybrid spring wheat from the cross Ruby \times Renown (spring wheat \times winter wheat) has showed some promise, and is being multiplied in 1941 for further testing.

The breeding work with winter wheat has as its chief object the production of good quality types, highly resistant to lodging, which will yield well over a range of soils—in contrast to the varieties Yeoman, Warden, Holdfast, &c., which require conditions of high fertility. Various crosses with this end in view were made in 1940. Selections from a Sun III. \times Mesopotamian vulgare cross were used as parents in some of these crosses. These selections have large flinty grains and large well-developed ears, but they have some defects with regard to other characters, which will have to be eliminated.

Beans.

A selection of Scots Tick and one of Spring Horse Bean were grown in $\frac{3}{4}$ -acre plots at the Station. Both crops grew satisfactorily and little damage was caused by the bean aphid.

The plants were not as heavily podded in 1940 as in 1939, but the yields of beans obtained were at the rate of about one ton per acre. The seed was secured in excellent condition. In view of the importance of protein for stock feeding, more attention might profitably be given by farmers to extending the acreage of beans on suitable soils.

An early-ripening type of field bean of Russian origin is being increased in quantity with a view to having it compared in field trials with those varieties at present in cultivation in Scotland. Several hybrid field beans were grown for selection.

Soya beans were grown on a small scale to maintain stocks of the varieties in the collection at the Station.

Linseed.

Samples of seed of varieties of flax which is grown mainly for seed were obtained from Canada and from the Argentine for the purpose of seeing how seed types of flax grow at Corstorphine. These were grown in small observation plots. The Canadian varieties produced good crops, and one of them, Diadem, gave the highest yield of seed, the rate being estimated at about 15 cwt. per acre. The Argentine varieties were received too late in the season to permit of their producing a full crop, but some seed was obtained from all of these for further trials.

POTATOES.

(Breeding and Genetics—Boghall Sub-Station.)

WILLIAM BLACK, B.Sc., Ph.D.

(Virus Diseases—Craigs House.)

GEORGE COCKERHAM, B.Sc., Ph.D.

C. H. CADMAN, B.Sc., Ph.D.

In the intercrossing of commercial varieties for the production of improved types, parent plants were chosen mainly from those kinds which are field-immune from the viruses A and X. About 900 seedlings were raised in 1940 in connection with these experiments, and among them there were many promising selections. The new potato Craigs Defiance.

which is field-immune from viruses A, B, C, and X, was frequently used as a parent, and various other varieties, some field-immune from A and X, had been crossed with it. In those progenies it may be presumed that many of the seedlings will be field-immune from A and X, and consequently remain unaffected by the two most serious mosaic diseases of the potato.

About 4000 new seedlings bred from blight-resistant parents were raised and tested for resistance to blight under controlled conditions. Approximately half of them proved to be susceptible and were killed off in the test. The resistant survivors were grown on to maturity and examined as possible economic types. Many promising plants were selected, and outstanding among them were derivatives of Craigs Defiance crossed with a blight-resistant un-named seedling. In making this cross the object is to combine the field immunity from viruses possessed by Craigs Defiance with the blight resistance of the male parent. Over 1000 seedlings of this particular combination were grown, and almost 500 of them proved to be resistant to blight.

Many blight-resistant selections produced in previous years were grown in comparative trials. A number of them compared favourably with standard commercial varieties and proved to be of very good cooking quality. There are 1st-Early, 2nd-Early, Early-maincrop, and Maincrop types among them, and they will be multiplied further in 1941.

It has been observed that the mode of inheritance of resistance to blight is no less complex than that of other characters of the potato. Complications were also unavoidably introduced at the outset by crossing the hexaploid species *S. demissum* with tetraploid cultivated varieties. However, resistance has proved to be dominant to susceptibility, and it appears that a heterozygous form of resistance can be retained indefinitely in repeated back-crossing to susceptible varieties so long as resistant plants are selected in each generation. These resistant heterozygotes are being intercrossed or self-fertilised with the object of building up a higher degree of resistance.

The effects of utilising various wild species in addition to *S. demissum* in the improvement of the potato are being investigated. Interesting results have been obtained from *S. polyadenium* (diploid), *S. Rybinii* (diploid), *S. andigenum* (tetraploid), and *S. edinense* (pentaploid). In addition, several

new species obtained from Mexico and South America in collaboration with the Imperial Bureau of Plant-Breeding and Genetics, were used for breeding purposes. Various hybrids, back-crosses, F_2 generations, and multiple hybrids were raised, and cytological examination of the material is in progress. Several of these new hybrid types give evidence of being of considerable value both for experimentation and for breeding improved commercial varieties.

Seedlings raised in previous years were grown in trial and multiplication plots at Craigs House and Boghall. Some of them were also included in the trials at Ormskirk carried out by the Ministry of Agriculture and Fisheries, and a very favourable report was received in respect of a number of them. The most promising will be multiplied further in 1941.

Samples of seedlings have been forwarded for inclusion in the Ministry's trials in 1941. They consist of one variety for the second year's trial, two for the first, and twenty for the preliminary test.

The stock of the Society's new variety Craigs Defiance, grown in 1939, was retained for multiplication, and about 3 acres were grown for the Society in the North of Scotland in 1940. A Stock Seed Certificate was obtained in respect of this crop, which was offered for sale to members of the Society in January 1941. Seed tubers, amounting to 25 tons, were distributed in one-ton lots, and a sufficient quantity of tubers was retained for planting about $1\frac{1}{2}$ acres in 1941.

Small quantities of tubers were also sent to certain centres in Scotland and England to undergo comparative trials with standard named varieties in 1940. The reports received were highly satisfactory.

A small multiplication plot of The Alness was grown at Boghall in 1940. This crop attained Stock Seed standard, and all the available tubers were sold as seed to members of the Society. A nucleus stock will again be grown in 1941.

Virus Diseases.

The nature and inheritance of resistance to virus attack continues to form the basis of investigations into virus diseases of the potato. The nature of 'field immunity' to viruses A, B, C, and X—*i.e.*, virtual immunity in the field

from diseases caused by these viruses—has been studied in the laboratory through the introduction of the four viruses into named varieties and seedlings in as natural a manner as possible as compared with the purely artificial method of infection by grafting. Successful infection was rarely obtained with sap inoculation of virus A. Viruses B, C, and X, however, were found to be readily inoculable into plants which gave anecrotic reactions to these viruses. Upon plants which showed symptoms of top necrosis when infected by grafting, sap inoculation either failed to infect or resulted in the formation of local lesions at the point of entry. With very few exceptions, no systemic infection of the plant followed the production of these lesions. Somewhat similar lesions have been observed in field-immune varieties grown under normal cultural conditions and exposed to natural infection, but as there are no means of determining whether they were due to virus entry or to injury, &c., the evidence in this respect is inconclusive. It is significant, however, that in careful inspections of field-immune varieties only very small numbers of plants showing full top necrosis were found.

These observations provide experimental evidence in support of the hypothesis that field-immune varieties, which react with top necrosis to graft infection, are so hypersensitive to the invading virus that when infection takes place in the field, through contact or the agency of insects, the systemic penetration of the virus is usually prevented by the production of a barrier of dead tissue, local necrosis, around the point of entry in advance of the necrogenic agent, the virus. Furthermore, in the few cases where the virus does become systemic, the necrotic plants by their early death are eliminated as potential sources of infection within the crop, and also as potential causes of ultimate degeneration through the vegetative reproduction of virus-carrying tubers.

Genetical investigations have been undertaken with three objects in view: to ascertain the mode of inheritance of the individual genes controlling reaction to virus infection, to examine the relationships between these genes, and to examine the distribution of the genes among cultivated varieties and 'wild' species. With regard to the four viruses A, B, C, and X, it has been found that the top necrosis reactions to each are separately determined by four genes, designated N^A , N^B , N^C , N^X , tetrasomic in their mode of inheritance and, when present,

dominant and in a single dose in most varieties. The N^A and N^X genes appear to be fairly closely linked. The location of N^B is at present uncertain, but the fourth gene, N^C , behaves as though it were situated in a different chromosome from the other three. Among cultivated varieties there is a marked low frequency in the distribution of the dominant N^X gene. The scarcity of this gene among our commercial varieties is of the greatest significance as a major factor affecting the health of potato stocks in Scotland.

For the purpose of improving technique, methods of infection alternative to grafting with the use of local lesions as efficient indicators of reaction, and the use of solanaceous species alternative to potato varieties as recovery indicators have been examined with promising results.

Resistance to leaf-roll virus and virus Y has been studied in progeny tests under natural conditions of infection in the field and through intensive infection by aphides under controlled conditions. Data of genetic value have been accumulated, and the indicative results so far obtained have been applied to the breeding of seedlings likely to prove resistant to leaf-roll and be field-immune from viruses A, B, C, and X. The effect of the abnormally high aphid populations recorded in 1939 upon the spread of leaf-roll in that year was seen in the field trials of 1940 when 74 per cent of the seedlings were found to be infected as compared with 25 per cent to 40 per cent in previous years. The spread of leaf-roll was almost as great in the Y virus trials, where, on the other hand, the spread of virus Y was only a little above the average for the previous three years.

This extraordinary spread of leaf-roll has also been recorded from certain other areas in Scotland, and has been responsible for many adverse reports upon the health of Scottish seed. An advisory officer of an English province was led, indeed, to request information upon the aphid populations of Scottish seed stocks during 1940. Fortunately the position was reassuring in that there were indications of generally average populations and late maxima in the areas from which estimates were obtained during the year. At the Plant-Breeding Station aphid populations were very low, indices of under 50, until 24th July, after which there was a rapid increase to fluctuating maxima about an index of 900 between 7th August and 11th September.

The maintenance of breeding stocks and the raising of new seedlings were carried out mainly at the Boghall Sub-station. Nine progenies containing 1215 plants were raised for inclusion in the leaf-roll trials. Two of these progenies form the beginning of a practical effort to combine field immunity from viruses A, B, C, and X, with resistance to leaf-roll and the preservation of the essential economic qualities. In addition, 15 progenies containing 1439 plants were raised for further genetical work upon the inheritance of reaction to the A, B, C, and X viruses. Seed has been obtained from 46 fertilisations.

HERBAGE PLANTS.

J. W. GREGOR, Ph.D., D.Sc., F.L.S.
J. M. S. LANG, B.S.A.

Since the investigations at Ainville had to be terminated towards the end of 1939, a trial area for testing the grazing value of the grass varieties raised at Corstorphine is not at present available and the need for such an area is now urgent. In the Ainville trials sufficient data were collected to show that encouraging results can be obtained, even in upland localities, by restricting the seeds sown to a mixture of varieties of a single highly productive species—*e.g.*, ryegrass—instead of using mixtures of different grass species. In the light of these data, and influenced by the needs of the present emergency, certain modifications of the grass-breeding programme have been made. For instance, emphasis has been transferred from the breeding of 'permanent' pasture components to the relatively less expensive and more productive constituents of arable grassland.

Every effort is therefore being made to increase as rapidly as possible seed stocks of an early and a late variety of perennial ryegrass (Ref. No. *Ca* 434 and *Ca* 448 respectively), two varieties which, together with Ayrshire perennial, gave good results in trials at Ainville. In addition, a re-selected stock of the cocksfoot variety *Cc* 180, and a hay variety of stiff-strawed timothy (*Cb* 224), are being multiplied, and it is hoped that from the $\frac{1}{2}$ acre allotted to each variety a limited quantity of seed of all these four may be available for disposal early in 1942.

Meadow Foxtail.—Seed of foxtail was obtained from an

old meadow on Blythe, Lauder, last autumn. It is intended to seed about quarter of an acre next year to supply a very limited demand from farmers who desire to introduce indigenous foxtail on a small scale into favourable localities on hill grazings.

Grazing Nurse-Crops.—Several different species of plants have been examined to ascertain their suitability as grazing nurse-crops. On land ploughed with the specific object of immediately re-seeding to grass the seed mixture has to be sown without the customary grain-producing nurse-crop. In place of the grain crop some early and rapid-growing plant is required as a grazing nurse-crop—a plant that will provide grazing, or silage, during the time the grasses and clovers are establishing themselves. The oat varieties Sandy and Grey Winter have given satisfactory results, since they reach the grazing stage early and have a growth habit which promotes the quick establishment of the grasses and wild white clover, the rapid spread of the latter being absolutely essential to the successful growth of the highly productive grasses such as ryegrass on poor upland soils. Certain rye varieties are also likely to be useful in this connection—*e.g.*, Scotch Winter Rye. Varieties of spring rye have so far proved to be inferior to oats. Michels Grass (probably a variety of rye) obtained from America has been sown in trials this year. For late-ploughed land a grazing variety of winter barley would be valuable, and the Department of Agriculture for Scotland has kindly undertaken to import from the U.S.A. for the Society a winter variety which has given good pasturage in Missouri under winter conditions, which appear to be not dissimilar to those obtaining in Scotland.

Late Perennial Ryegrass Seed.—At present the growing of late ryegrass, a valuable constituent of any simple seeds mixture, on a commercial scale is a relatively costly process. Seed yields are frequently much reduced as a result of fungus attack, and the consequent financial loss cannot be offset by spring grazing or an early hay cut when the crop is grown in pure culture. Preliminary investigations have, therefore, been started with a view to determining the practical possibilities of raising disease-free first-generation seed for pasture purposes from a mixed population of early and late true-breeding strains. First-generation seed has already been obtained on an experimental scale with satisfactory results.

On a field scale the method offers the prospect of obtaining early pasturage or a hay crop in the seed-harvest year.

Experimental Taxonomy.—The study of the breeding structure of wind-pollinated populations has been continued in so far as present circumstances have permitted. Although the investigation is now more or less in abeyance, it is nevertheless hoped that it may be possible at some later date to gain further information relating to the composition of plant populations from material retained for future study.

ROOT CROPS.

(*Swedes and Kåles.*)

V. M. M. DAVEY, B.Sc., Ph.D.,
J. M. S. LANG, B.S.A.

Swede Breeding.

Methods of breeding and selecting swedes form the main basis of the work with this crop plant. The ability of the swede to set seed with its own pollen has been used to advantage for studying the effects of self-fertilisation. Controlled self-fertilisation has been practised in this crop plant without deleterious effect. Inbred lines, derived from good plants of a commercial stock, were frequently as good as, and sometimes slightly better than their parent variety in feeding value, and also compared favourably in regard to uniformity of type. For the production of re-selected or improved strains, the inbred line method may have practical value, especially if the relative yields of the lines and variety are ascertained in trials. But as a means of originating a new variety, a plant selected from an existing variety seldom gives rise to a strain which is sufficiently distinctive as well as valuable.

Instead of selecting new lines from commercial stocks, attention has latterly been concentrated upon combining the characters of different lines by hybridisation. Hybrid strains were selected from the second and later generations of the crosses, and were propagated by selfing; they provided the chief interest of the 1940 trials. Though still far from true breeding, many of the strains were recognisably uniform for various characters, and some opinion could be formed as to

their value; five of them are multiplied for further testing. In order to explore the whole field of available material, crosses have been made in past years between purple-, bronze-, and green-top swedes in every combination. The requirements of the market, however, make it desirable that a new variety should have a purple skin-colour if possible. This type cannot arise out of any combination of bronze- or green-tops, because these lack a major factor for colour production. There are, however, minor factors for intensifying the colour, which may be present in the bronze-top, but are absent from the green-top. Consequently good purple skin-colours can be obtained readily from crosses between purple- \times bronze-top once the major factor has been fixed, but they are very difficult to obtain from crosses between purple- \times green-top. The purple-top derivatives of the latter cross have strongly coloured necks, but the top of the bulb is usually of an unattractive brown colour. Crosses between dark and light purple-tops give strains with good skin-colours, and no non-purple-tops occur if the parents are true breeding. In the earlier generations the plants vary in intensity of colour, but later one tone usually becomes true-breeding. It may be mentioned that the white-fleshed swede has a somewhat different constitution, and that bronze-tops can appear in the second generation when purple-top plants of white- and yellow-flesh strains have been crossed.

Pedigree Breeding and Trials.—Nearly four acres of swedes were grown, and three of these were laid out in large and small observation plots and yield trials. Parts of the crop were partial failures as a result of the drought, and some areas had to be resown with turnips. Hybrid strains in single or duplicated plots were tested for yield and dry-matter content.

Propagation.—Following the destruction or damaging of the breeding plants by the frosts of January 1940, the harvest was small and the seed poor in quality. It is hoped to avoid a similar setback in 1941, through having had duplicate selections kept over winter in cold frames protected by straw. The plants which were wintered outside have again been damaged or destroyed, and they have been replaced by duplicates from the frames which appear healthy. In mild winters the outdoor plants suffer much less from disease than those stored in a frame.

Finger-and-Toe Disease.—The testing of seedlings for resistance to finger-and-toe disease was again carried out on

more than 3000 plants. The seedlings were pricked out into shallow boxes of partially burnt soil, and infection was applied as an aqueous extract of minced nodules. The cabbage root-fly was successfully deterred from laying eggs in the boxes by applications of flake naphthalene at ten-day intervals, without harm to the plants. During a scarcity of this commodity, the 'triple-ring' form of naphthalene was tried, but caused damage to the very young plants, and calomel dust also proved harmful if it came in contact with the cotyledons.

Kale Breeding.

The thousand-headed kale strain, T1, is characterised by possessing plain, uncurled leaves and an erect habit of growth; it is also peculiar in being self-fertile. There is considerable variability in minor characters among the plants of the strain, which are all descended from a common ancestor. Thirty lines were observed in 1940, and some of the variations were seen to have been inherited. Selection is being made for early development of side shoots, and also for a tendency to grow new leaves in the top region during early autumn. The other strains of thousand-headed kale were extremely self-sterile, and attempts were made to propagate these by crossing similar types, as well as by selfing.

During the two severe winters, 1939-40 and 1940-41, the marrow-stem kale material has been entirely destroyed. The plant is too susceptible to frost, which causes rotting of the pith. The thousand-headed kales proved relatively hardy, and most of the breeding plants survived. A number of plants were selected for resistance, from a badly damaged field plot, and these were successfully seeded in 1940.

It was decided at a meeting in October of the Society's Roots Sub-Committee that the acreage of experimental plots should be reduced and that arrangements should be made to substitute vegetable crops for seed-production and for food in place of some of the experimental work. If it is found practicable to seed one of the cabbage tribe, such as brussels sprouts or broccoli on a field scale, the kale breeding will have to be suspended to avoid contamination, but this will not be necessary till 1942.

CYTOLOGICAL WORK.

J. M. MAIN, B.Sc. (*resigned* September 1940).
MARGARET F. TORRANCE, B.Sc.

The examination was continued of the *Brassicæ* material mentioned in the last report. Some seedlings which had been treated with colchicine were also examined, but no definite evidence of somatic differences was noted. A so-called Perpetual Kale was found to have a swede-like chromosome construction, 38 chromosomes being present in the somatic cells. Numerous *Solanum* root-tips which had been collected during 1939 were prepared and examined.

Root-tips of a large number of seedling barleys were examined. These plants were raised from seed produced by plants which had been treated with colchicine in 1940. As already reported, several tetraploid forms were distinguished among the normal diploid types.

II. Publications.

J. W. Gregor, Ph.D., D.Sc., F.L.S. :—

"Units of Experimental Taxonomy." (In Press.)

Contributions to the technique and philosophy of plant taxonomy and geography, Vol. I.

III. Visits.

V. M'M. Davey, B.Sc., Ph.D. :—

Craibstone Experimental Farm, Aberdeen.

IV. Demonstrations.

During the summer visitors were conducted round the experimental plots and various aspects of the work were described by members of the staff.

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