1948

# SCOTTISH SOCIETY FOR RESEARCH IN PLANT-BREEDING.

## REPORT.

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

In connection with the development of the estates of The Bush and Dryden by Edinburgh University for purposes of education and research, referred to in our previous Annual Report, progress is being made as rapidly as circumstances permit, and this Society has been allotted provisionally an area of land for plant-breeding experiments. The view held at present is that there will be considerable delay in having the necessary offices, laboratories, and greenhouses erected there, and on that account it will be about 1950 before a beginning can be made to move the Plant-Breeding Station from Corstorphine to its new site. In the interval, however, endeavour will be made to develop the Society's programme of work to the fullest extent practicable at Corstorphine.

During the past year the work at the Plant-Breeding Station has continued to expand, and some entirely new investigations dealing with the breeding of sugar-beet for Scottish conditions have been initiated in response to a request from the National Farmers' Union of Scotland. It is expected that this work will be increased considerably in volume in the next few years so that results of practical value may be achieved as rapidly as possible.

In January 1948 two of the Society's seedling potatoes were registered as new varieties by the Department of Agriculture for Scotland. These varieties had been included in trials for several years and had given promising results. The first seedling, Ref. No. 831(113), has been named "Craigs Royal," and the second seedling, Ref. No. 835*a*(4), has been named "Craigs Snow-White." Descriptive notes of these new varieties are given on pages 16 and 17 of this Report.

An account of the work at the Plant-Breeding Station, Corstorphine, at the sub-station, Boghall, and at Dundonnell is given in the Report by the Director of Research on pages 5 to 33.

The Directors wish to take this opportunity of expressing their thanks to Messrs David Bell, Ltd., Leith, for their valued assistance again in cleaning, storing, and despatching bulk quantities of cereals and grass seeds for the Society from last season's crops, which could not be accommodated at the Plant-Breeding Station.

## Staff.

The Directors have pleasure in reporting that the Society's scientific staff has been assimilated to the White Paper Salary Scales (Scientific Civil Service) as from 1st January 1946 in accordance with a scheme adopted by the Department of Agriculture for Scotland and the Agricultural Research Council.

By invitation of the British Council and with the approval of the Department of Agriculture for Scotland, Dr Cockerham visited Hungary towards the end of 1947, and during his stay of two weeks there he gave a number of lectures describing his work on virus diseases of potatoes. General Sir Ronald Adam, Chairman of the British Council, in thanking Dr Cockerham for assistance given to the Council, intimated that the visit filled a need badly felt by the Hungarians and that fruitful new fields of contact had been opened up. The Council's representative in Hungary reported that the tour had been a great success.

A request was received from the Director of Agricultural Production, Tanganyika, that Dr Black should be allowed

to visit the territory in order to advise him regarding the growing and development of the Society's disease-resistant potatoes in that country. Some of the Society's seedling potatoes had been giving promising results there, and it was agreed by the Directors of the Society and approved by the Department of Agriculture for Scotland that Dr Black should be granted leave of absence to visit Tanganyika in February and March 1948. Dr Black spent about one month in Tanganyika and he found it profitable seeing how the Society's seedlings were cropping and were reacting to diseases in that country.

## Membership.

The Directors regret to report that in the past year six members died and three members resigned. They are pleased to record, however, that nineteen new members were elected during the year; two of these became life members. At 31st March the membership numbered 373, and consisted of 164 life members and 209 annual members (15 at the 5s. rate and 194 at the 10s. rate of subscription). A list of members appears on pages 36 to 46 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.

Intimation has been received from the Agricultural Research Council that the Scottish Society for Research in Plant-Breeding has been approved as a Research Association for the purposes of Section 27 of the Finance Act, 1944. "Payments by an agriculturist to an approved institution engaged on agricultural or horticultural research will rank as an expense in his accounts for the purposes of income tax even if intended as a contribution towards a definite capital project to be carried out by the research organisation."

## List of Varieties of Crop Plants raised or selected by the Society and introduced into Commerce.

*Oats*—

| | | Date of Registration. |
|---|---|---|
| Elder | Registered by the Department of Agriculture for Scotland as new varieties. | 1930 |
| Bell | | 1932 |
| Early Miller | | 1934 |

*Wheat*—

Scottish Iron III.

*Barley*—

Craigs Triumph.

*Potatoes*—

| | | |
|---|---|---|
| The Alness | Registered by the Department of Agriculture for Scotland as new varieties. | 1934 |
| Craigs Defiance | | 1939 |

*Grasses*—

"Scotia" Cocksfoot, Ref. No. *Cc* 196.
"Scotia" Timothy, Ref. No. *Cb* 224.
Perennial Ryegrass, Ref. No. *Ca* 448.

# REPORT

BY

# DIRECTOR OF RESEARCH

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## I. Research Programme.

### GRAIN CROPS.

WILLIAM ROBB, *Director of Research.*
DONALD CAMERON, B.Sc.

#### *Oats.*

Through the willing and helpful co-operation of the three Agricultural Colleges in Scotland; the National Institute of Agricultural Botany, Cambridge; and the National Agricultural Advisory Service, Northumberland, several unnamed varieties of oats bred at the Station were included in field trials in different regions of Scotland and England in 1947. The spell of dry weather in the summer doubtless had the effect on the lighter soils of reducing grain yields, especially of the shorter-strawed and the earlier-ripening varieties. Conditions generally were not conducive to lodging and little information could be gained regarding this characteristic. Varieties which had shown much promise in 1946 gave less impressive results in 1947. It would therefore seem that the shorter-strawed varieties, which have been bred for resistance to lodging, require a high degree of soil fertility and a more adequate supply of moisture to enable each variety to give a yield approaching that of its maximum.

The undernoted unnamed selections (indicated by reference numbers) are among the more promising of the varieties being tested at the Plant-Breeding Station and included in regional trials in 1947.

*Aa* 676, bred from Castleton Potato and Yielder, has comparatively short straw which is highly resistant to lodging; it ripens early, has white, well-filled and small grain. It has consistently given good results on Milton of Edinglassie Farm, in the Upper Donside area of Aberdeenshire, at an altitude of about 1100 feet, where it is reported to be early, to have straw of good quality, and to have threshed on the average over 24 cwt. of grain per acre. In trials in the North of England *Aa* 676 was better than Early Miller, but it gave a lower yield of grain than Victory.

*Aa* 698, bred from Star × Marvellous, has straw of medium length which has not lodged readily at Corstorphine; it ripens medium early and has large white grain. It has given rather inconsistent results, and the grain in 1947 was not as well filled or attractive as it has been in some previous years.

*Aa* 708, bred from (Castleton Potato × Yielder) × Elder, has comparatively short straw which has shown a high degree of resistance to lodging. It is early ripening—at Corstorphine about one week earlier than Victory—has well-filled white grain of medium size. In 1945 and 1946 this variety was outstanding as regards resistance to lodging in trials at Craibstone, Aberdeen. In trials at Northumberland in 1946 it was also noted for its resistance to lodging. To reach its maximum yielding capacity this variety requires high fertility, and where an oat crop is to follow lea in which there was an ample amount of wild white clover this variety merits consideration. In trials at Craibstone in 1947 the variety was one of the first two to ripen, and it was eighth in order of total yield of grain—26.2 cwt. per acre compared with 28.0 cwt. from Star and 31.6 cwt. from Sun II. At Auchincruive, Ayrshire, the yield of grain was significantly lower than that of Victory and Sun II. Expressed as a percentage of Victory the yields were: Sun II. = 126 and *Aa* 708 = 82.

*Aa* 716. Bred from Early Miller × Bell, this variety is intended for trial under upland conditions. It has straw about the same length as that of the Potato oat, it ripens early, the grain is white and of medium size.

*Aa* 718 was bred from Elder crossed with a very early-

ripening, unnamed selection which was derived from several crosses in the pedigree of which the varieties Victory, Black Mesdag, Orion, Beseler's Prolific, and Eighty-Day occur. This selection is intended for upland conditions; it has straw of medium length, it ripens early, the grain is white and of medium size. In a trial at Boghall this variety gave a yield of grain slightly, but not significantly, higher than that of Victory.

*Aa* 719 was bred from an unnamed hybrid selection which was crossed with Yielder, the unnamed selection being derived from crosses which have the varieties Victory, Black Mesdag, and Yielder in their parentage. This variety may be useful for general purposes or for upland conditions; the straw is fairly strong and of medium length, it ripens a few days earlier than Victory or Star, the grain is white and of medium size. In trials at Boghall this variety gave a yield of grain higher, but not significantly higher, than that of Victory, but significantly higher than that of Yielder. This variety was fourth in order of total grain yield in trials at Craibstone, Aberdeen, in 1947, with a yield of grain equal to that of Star—viz., 28.0 cwt. per acre.

*Aa* 720, bred from Early Miller × Progress, is being tried as a general-purpose type; it has straw of medium length, is resistant to lodging, ripens early, the grain is white and well filled, and in small-scale trials at Corstorphine has been among the higher grain-yielding selections. It gave a yield of grain similar to that of Victory in trials at Boghall, 1947, and in a trial at Auchincruive it gave a yield of grain significantly lower than that of Sun II., and lower but not significantly different from that of Victory.

*Aa* 721. The original plant from which this selection was derived was a variant type which occurred in the variety known as Semi-dwarf. This selection is definitely a special-purpose type for growing on land in a high state of fertility; the straw is short and stout, and it has given indications of being highly resistant to lodging; it ripens medium early, the grain is white of medium size and fairly well filled. At Craibstone it was among the first to ripen and, with a total yield of 25.7 cwt. of grain per acre, was ninth out of fourteen in order of yield, Sun II. being highest with 31.6 cwt.

At the Plant-Breeding Station, Corstorphine, twenty-five hybrid oat selections were included in small-scale replicated

trial plots. Sowing of the seed was not practicable until after 10th April, and in order to avoid further delay a start was made with the sowing of the grain before the land was in a really suitable condition for seeding small plots, where much hand-work is necessary. After the seed had germinated, conditions for growth were not very favourable, and throughout these plots the stem eelworm caused considerable damage. Most of the varieties showed signs of attack, but although some suffered more than others it was not possible to establish definitely whether any varieties were more susceptible to attack than others. On account of the eelworm damage reliable comparisons of grain-yielding capacity could not be obtained. None of the selections was entirely destroyed, and seed was obtained from all of them.

In 1947 the grain in general was not so well filled as in 1946, but its colour was much better on account of the dry weather before and during harvest. The thousand-grain weight and the percentage kernel or groat were determined in each variety included in the comparative trial. The thousand-grain weights ranged from 34.8 gm. on one variety with small grain to 45.4 gm. in a variety with large grain.

The oat *Avena byzantina* is deemed to be tolerant of lime and it was therefore crossed with a cultivated oat of the *sativa* type with a view to breeding an oat that would be better adapted than the cultivated (*sativa*) types to alkaline soil. Progenies from this cross have been grown and selections made at the Station for several years, and in 1947 Mr A. G. Malcolm, County Organiser, Argyll, kindly arranged for a small-scale trial of an unfixed selection on alkaline soil on Mr John M'Arthur's farm of Middleton, on the island of Tiree, in order that this selection would be tested under the soil and climatic conditions prevailing there. A report on the trial, received from Mr Malcolm, indicated that this selection had shown much promise; it had grown well and had attracted considerable attention. The farmer was keen to retain all the seed for a larger trial plot in 1948 and it has been agreed that this seed should be used for that purpose. By growing the unfixed selection on alkaline soil there should be a greater chance of detecting the more suitable types in the group for such soils. As the oat is a self-pollinating plant, a large proportion of the different types in the " bulk " crop should be

fixed, or breeding comparatively true to type, within the course of the next few years.

The oat-breeding work was continued with the same objectives in view as in previous years, and about the usual amount of unfixed hybrid material was grown as spaced plants. In breeding to obtain shorter-strawed plants with a high degree of resistance to lodging, the Semi-dwarf oat has been used as a parent for crossing, but many of the hybrid selections produced from the Semi-dwarf crosses have proved disappointing. They had short, stout straw, but gave low yields of grain. One attractive type with short, strong straw has, so far at any rate, proved impossible to fix—a range of segregates differing from the selected type has continued to appear in every generation. From several other crosses selections showing promise have been obtained from the following combinations: Abundance × Early Miller, Eagle × Bell, Beseler's Prolific × Early Miller, Early Miller × Elder, Onward × Early Miller, Marvellous × Orion.

Samples of grain from over 150 plant selections taken at harvest time from crosses between the wild oat (*Avena fatua*) and cultivated (*A. sativa*) varieties were tested in a greenhouse for prompt germination, the objective here being to find a suitable type of oat the grain of which will not readily germinate in the stook during mild, wet weather. Some useful white-grain types have been obtained, but although only plants having grain which showed resistance to prompt germination at harvest time have been selected for several generations, uniformity of type as regards this characteristic has not yet been found in any selection. Individual plant selection is, of course, being continued.

It is well known that exposure of seeds to X-rays can induce mutations. In view of the interesting plant-breeding results which have been obtained abroad, arrangements were made early in 1947 with Dr J. G. Carr, Institute of Animal Genetics, King's Buildings, Edinburgh, and with Dr C. A. Murison, Radiology Department, The Royal Infirmary, Edinburgh, to have the seeds of a few selections of oats, wheat, and barley exposed to certain amounts of X-rays. The treated seeds were sown in plots at Corstorphine last year; they showed a reduced percentage of germination, but mature plants were obtained from each lot of treated seed. The

grain obtained from these lots has been sown this spring, and observations will be made on the resulting plants to detect variant types. Up to the seedling stage the only variants seen have been a few albino seedlings (*i.e.*, plants lacking green colour) in one variety of barley.

*Colchicine Treatment.*—Various techniques were tried on germinated seed and seedling plants of *Avena strigosa* and *A. brevis* with the object of determining which method was best for promoting chromosome duplication.

It was concluded that the method described by E. R. Sears in the Research Bulletin 336, University of Missouri College of Agriculture, 1941, while the most expensive in colchicine, was the only really promising one to use with oats. This method involves the treatment of potted plants in the seedling stage, and a high percentage of success is claimed.

*Interspecific Hybrids.*—A large number of hand pollinations were made between the diploid *Avena strigosa* and the tetraploid *A. barbata* in both directions, as a result of which a few presumed hybrid grains were obtained. These, if viable, will give sterile triploid plants, and it is proposed to use Sear's colchicine technique in order to obtain fertile hexaploids.

The Murkle, Myrtle or Orkney oat is an old variety which appears to have been grown to a considerable extent many years ago in the North of Scotland and in the Orkney Islands, and apparently is still grown in a few areas. The grain of this variety is awned, reddish-black in colour, long, and rather poorly filled as compared with, say, the grain of the Potato oat, but it was reputed to have had a higher oil content than other varieties. It was desired to ascertain if the variety at the Plant-Breeding Station grown under the name Myrtle also showed higher oil content than modern varieties. On mentioning this characteristic of the old Myrtle oat to Dr James Sword, Cereal Laboratory, Regent Mills, Glasgow, he kindly agreed to examine the seed for oil content and also for vitamin B content. Samples of grain of Myrtle oat and Star oat, both grown at Corstorphine under similar conditions, were sent to Dr Sword for examination, and he has reported that there was a significant difference in oil content but none in vitamin $B_1$. He estimated that the Myrtle groat contained about 9½ per cent oil and that the Star groat contained about 7½ per cent oil. The difference in plumpness of the two types

of grain is shown by the figures for the weights of a thousand groats of each variety, the figures being for Myrtle and Star 16.7 gm. and 31.7 gm. respectively.

Six acres of Early Miller and one acre of Bell oats were grown, satisfactory crops were obtained, and all the available grain was sold for seed. The amount of seed applied for was considerably in excess of the amount available.

*Barley.*

About two acres of Craigs Triumph barley were grown at the Plant-Breeding Station, and all the surplus grain was sold for seed. Favourable reports continue to be received from the North-East of Scotland regarding this barley.

The collection of named varieties of barley was again grown in small plots for observation and demonstration.

The harvesting of barley by the combine harvester has had the effect of emphasising, from the maltster's point of view, the importance of dormancy in barley. Dormancy is detrimental, and some barleys have a longer dormancy period after harvest than others. Dr L. R. Bishop in the 'Journal of the Institute of Brewing' published results a few years ago showing that Scots Common barley had a short dormancy period—*i.e.*, the grain had greater "germinative energy" shortly after being harvested as compared with that of the grain of the widely grown variety Plumage Archer. In response to a request received from Dr Bishop, a few varieties of barley, including some strains of Scots Common from the collection grown at Corstorphine, were sent to him immediately after the barleys were ripe for examination as to dormancy. Dr Bishop found that some of the strains of Common barley had a much higher percentage germinative energy—*i.e.*, less dormancy—when tested between 15th September and 1st October 1947 than had Plumage Archer and Spratt Archer. Two strains of Scots Common barley showed 85 per cent germinative energy, while Spratt Archer and Plumage Archer showed only 26 per cent and 16 per cent respectively. In view of the shorter period of dormancy in Common barley a few crosses between this barley and some other varieties of barley were attempted.

### *Wheat.*

The collections of named varieties of winter wheat and spring wheat were again grown.

### *Beans.*

Some 250 plants of the ordinary field bean were successfully seeded, each plant being "bagged" during the flowering period to prevent natural intercrossing. Notes were made throughout the growing season on flower and stem colour, and on the size, shape, and colour of the seed after it had ripened. On unbagged sister plants, average height, date of ripening, and podding capacity were noted. From the data obtained, the amount of variability in the various pedigree lines has been assessed, and those which appeared to be true-breeding were selected for multiplication in spatial isolation.

The most attractive of the lines which were multiplied in 1947 are being multiplied further in 1948 for inclusion in subsequent trials.

A trial is being carried out, using six distinctive lines, one with albino flowers, to determine the degree of spatial isolation required to prevent natural intercrossing between small lots growing amongst wheat.

The second hybrid generation populations from crosses made in 1946 are being grown to yield information for inheritance studies and material for future breeding.

## Potatoes.

### (*Breeding—Boghall Sub-Station.*)

William Black, B.Sc., Ph.D.
J. C. Haigh, B.Sc., Ph.D., A.R.C.S.

The main object of the potato-breeding experiments is to evolve varieties which are suitable for commercial purposes and which have a high degree of resistance to the more important diseases. The range of potential material now available contains valuable qualities such as immunity from blight, field immunity from the mosaic viruses A, X, and Y, resistance to leaf-roll, and resistance to scab. The prospects of eventually accumulating all these disease-resistant qualities in economic varieties are encouraging, but it is apparent that

with so many different factors involved, the numbers of seedlings which will require to be grown and tested must necessarily be very large in order to give the full range of recombinations.

Further progress has been made in breeding for blight resistance and in the investigations concerning the inheritance of resistance and the inter-relationships between the strains. Accounts of the work with the three strains A, B, and C have been published in 'Agriculture,' Vol. LIV., No. 5, 1947. A fourth strain of blight, D, was isolated in 1946, and tests with it were carried out in 1947. It was found to be related to the C strain, but was substantially weaker in virulence. An article dealing with the inter-relationships of all four strains is at present in the Press.

In recent years breeding has been directed towards the production of seedlings immune from all strains of blight, and as a result a high proportion of such seedlings is present among the first and second-year selections, while a few are now undergoing extended trial.

On account of the practical value of field immunity from viruses X and A, commercial varieties and seedlings possessing these qualities have been used as far as possible in routine hybridisations. As a result, many of the new seedlings possess these characteristics in combination with blight immunity. The laboratory tests to ascertain the reaction of seedlings to viruses A, B, C, X, and Y were carried out by the Potato Virus-Disease Section.

The breeding experiments designed to obtain suitable parent types possessing field immunity from virus Y were continued. Self-fertile tetraploid plants have now been bred which are hypersensitive to virus Y and immune from blight, but they still exhibit too many characteristics of their wild ancestors. Improvements, however, will no doubt be effected by further crossing.

A few specimens of potatoes which give a necrotic reaction to virus Y were kindly supplied by Mr E. M. Hutton, Australia. Some of them have been employed as parents in breeding experiments, and the reactions of the resulting seedling selections will be ascertained during 1948.

Leaf-roll resistant varieties, including a few of German origin, have been used as parents in breeding experiments. Some of the resulting seedlings have compared favourably in initial trials with the control varieties, but as no convenient

laboratory test for resistance has yet been devised it is impossible to assess their reaction with any degree of accuracy at this stage.

The conditions under which the seedlings were grown in 1947 were specially suitable for the development of both common and powdery scab. Very wide differences in susceptibility occurred in seedling progenies and this provided useful information for further breeding operations. Several attractive selections have been obtained which appear to possess a high degree of resistance to these two scab diseases.

Investigations have been continued with the object of utilising the desirable characters of the Mexican and South American species. Incompatibility and female sterility factors present a number of problems and experiments dealing with them are in progress. In order to facilitate hybridisation with economic types, wild species were first grafted on to commercial varieties and pollen was, in due course, applied to the flowering scion. For the same purpose various specimens were treated with colchicine and their chromosome complements were successfully doubled.

It is understood that immunity from blackleg is to be found among the exotic species, and tests are being carried out to confirm this with the object of utilising such plants in breeding experiments.

During the winter some investigations were made regarding the vitamin C content of the tubers of a collection of seedlings and commercial varieties. The amounts of vitamin C found in the commercial varieties were in accord with data published by other workers. The range observed amongst the seedlings was much wider than that among the commercial varieties, several seedlings being higher in vitamin C content than the best of the controls. It appears possible, by means of such analyses, to breed and select for the improvement of vitamin C content, but its application is limited by the comparatively laborious nature of the work and by the rapid loss of vitamin C in storage.

During 1947 over 17,000 new seedlings were raised. Apart from 721 seedlings which were bred from blight-susceptible parents, all were tested with the B strain of blight. Over 5000 of the seedlings which survived this test were planted in the field and grew to maturity, and 774 were retained at the end of the season for further trial in 1948.

430 second-year seedlings were grown in small plots of

four plants each and 118 of them were selected for further test in 1948. The majority of these were bred to combine blight immunity with resistance to one or more of the common viruses.

145 third-year and older seedlings were grown in plots varying in size from 6 to 48 plants each according to the seed tubers available and the estimated merit of the selection, and 55 seedlings were selected for further trial in 1948.

The 1947 Lord Derby Gold Medal Trials included four of the Society's seedlings—viz., 831(113), 833*b*(98), 834*c*(29), and 835*a*(4). Owing to adverse weather conditions the trials were not regarded as conclusive, and the Society was invited to submit three of the seedlings for retrial in 1948. The fourth seedling, 835*a*(4), was not recommended for retrial because it did not show sufficient advantage in yield over the control varieties and the tubers were not sufficiently attractive in shape.

TABLE I.

| Reference Number | Maturity | Immune from blight strains | Field-immune from viruses | Trials | | |
|---|---|---|---|---|---|---|
| | | | | L.D.G.M. Year | M.O.A.F. Year | D.O.A.S. Year |
| 831(113) Craigs Royal | 2nd E. | — | X, A. | 2nd | + | 3rd |
| 835*a*(4) Craigs Snow-White | M. | A, C. | X, A, B, C. | 3rd | + | 3rd |
| 833*b*(98) | E.M. | A, C. | X, A, B, C. | 2nd | + | + |
| 834*c*(29) | 2nd E. | A, C. | X, A, B, C. | 1st | + | 2nd |
| 653*d*(22) | E.M. | A, C. | C. | — | 2nd | — |
| 1092*a*(4) | E.M. | A, C. | B.* | — | 2nd | 1st |
| 827*a*(185) | 1st E. | — | A, B. | — | 1st | 2nd |
| 829*a*(109) | 2nd E. | — | * | — | 1st | 2nd |
| 1085(6) | M. | A, C. | * | — | 1st | — |
| 1321*c*(5) | M. | A, B. | X, B.* | — | 1st | — |
| 911*a*(100) | 2nd E. | — | A, C.* | — | — | 1st |
| 914*a*(12) | M. | A, C. | X, A, B, C. | — | — | 1st |
| 931*a*(3) | E.M. | A, C. | B.* | — | — | 1st |
| 1081*a*(2) | 2nd E. | A, C. | C.* | — | — | 1st |
| 1082*a*(34) | 2nd E. | A, C. | B, C.* | — | — | 1st |
| 1266*a*(3) | E.M. | A, C. | A, B. | — | — | 1st |
| 1318(3) | E.M. | A, B. | X, A, B. | — | — | 1st |

* Virus tests incomplete.

*Key to contractions :—*
M = Maincrop.
E.M. = Early maincrop.
1st E. = 1st Early.
2nd E. = 2nd Early.
\+ = Trials completed.

L.D.G.M. = Lord Derby Gold Medal Trials.
M.O.A.F. = Ministry of Agriculture and Fisheries Trials.
D.O.A.S. = Department of Agriculture for Scotland Trials.

In the trials conducted by the Ministry of Agriculture and Fisheries at Sutton Bonington six of the Society's seedlings were represented, four in the first and two in the second-year test. A sample of one of the seedlings in the second-year test has been requested by the National Institute of Agricultural Botany for multiplication, with a view to more extensive trial under uniform conditions.

The Registration Trials conducted by the Department of Agriculture for Scotland contained thirteen of the Society's seedlings. Of the eight included in the first-year trials, four were recommended for further trial in 1948. The second-year trials contained three seedlings, of which two were recommended for inclusion in the third-year trials in 1948—viz., 827*a*(185) and 834*a*(29).

The third-year trials contained two of the Society's seedlings—viz., 831(113) and 835*a*(4). These seedlings compared favourably with the control varieties and were recommended for registration. They have since been named " Craigs Royal " and " Craigs Snow-White " respectively. They are officially described as follows :—

*Craigs Royal.*

*Maturity.*—Second early.

*Tuber.*—Oval to long oval; parti-coloured pink; eyes shallow; flesh white; sprouts pink.

*Foliage.*—Haulm of medium height providing good cover; stems few, green with slight tinge of colour at the internodes, nodes green and slightly swollen, wings narrow and straight; leaf medium to long, rather broad, close and slightly rigid, midrib lightly coloured at base of leaflet stalks; leaflets large, broad, medium to dark green, glossy with a thin appearance, petioles fairly long and lightly coloured in young leaves, terminal leaflet rounded; secondary leaflets fairly numerous, medium in size and rounded.

*Flower.*—Red-purple, tipped white, rarely observed; buds drop readily.

*Craigs Snow-White.*

*Maturity.*—Maincrop.

*Tuber.*—Oval to kidney; skin white; eyes shallow; flesh white; sprouts pink.

*Foliage.*—Haulm of medium height and spreading, cover good; stems green with faint brown colouring at internodes, branching mainly at top; wings fairly large, waved especially at tops; nodes green and slightly swollen; leaf of average size, broad, somewhat open, midrib green with slight colour at base of leaflet stalks; stipule-like growth large; leaflets light green, medium to large, matt, margins slightly waved, lobes mainly uneven, terminal leaflet round, cordate and drooping, leaflet petioles brown; secondary leaflets fairly numerous, small, rounded, no leaflets between terminal and first pair of laterals.

*Flower.*—White, frequent, large; anthers orange, anther column sometimes irregular; petals sometimes separating; flower stalk long and bronzed; buds brownish-green with green base.

Multiplication plots of the four seedlings in the final stages of trial were grown in 1947 at Mains of Esslemont, Aberdeenshire, through the kind offices of Major James Keith, Pitmedden, Udny. The quantities of seed tubers obtained were approximately as follows:—

| | |
|---|---|
| 831(113) . . . . . | 240 cwt. |
| 833*b*(98) . . . . . | 53 cwt. |
| 834*c*(29) . . . . . | 40 cwt. |
| 835*a*(4) . . . . . | 43 cwt. |

Arrangements have been made to grow in 1948 in Aberdeenshire approximately 5 acres of 831(113)—Craigs Royal; ½ acre of 883*b*(98); 1 acre of 834*c*(29); and 2 acres of 835*a*(4)—Craigs Snow-White. In addition, regional field trials of 831(113)—Craigs Royal—have been arranged at seven centres, each centre being supplied with 15 cwt. seed tubers. The control variety will be Epicure.

The maintenance of virus-free stocks of the more promising seedlings which are undergoing official trial is regarded as an

essential part of the potato-breeding programme, and the Society is indebted to Sir James Denby Roberts, Bt., Strathallan Castle, Auchterarder, for co-operation in this work and for providing facilities for growing limited quantities of tested material. Tested units of five seedlings and a tested stock of Craigs Bounty were grown in isolation plots at Strathallan in 1947, and arrangements have been made to have several additional seedlings grown in 1948. These stocks will eventually be available for distribution as required.

Although the potato is indigenous to tropical America, its cultivation in tropical and subtropical countries has not advanced to the same extent as it has in temperate zones. The enthusiasm of potato breeders in the past has resulted in the development of potato varieties to suit European and North American conditions, but these varieties are seldom commercially successful under the short but intense daylight conditions and the greater heat of the tropics. Nevertheless, given suitable varieties, heavy yields can be obtained. Several of the Society's seedlings have given very encouraging results under tropical conditions, particularly 833*b*(98), 835*a*(4), 914*a*(12), 914(91), and 914*b*(52), and their cultivation is rapidly being extended. In East and South Africa the blight fungus (*Phytophthora infestans*) has become a menace to the cultivation of established varieties, but the above seedlings have so far remained free from the disease. Some of them are now being multiplied on a commercial scale for the purposes of distribution to farmers. A request was made to the Society by the Department of Agriculture, Government of Tanganyika, that Dr Black should visit Tanganyika to inspect the crops there and to study the conditions under which potatoes are cultivated in the tropics. Dr Black accepted the invitation, and leave of absence for five weeks was granted to enable him to visit East Africa in February and March 1948. The tour was highly interesting and instructive and valuable experience in tropical agriculture in general and in the cultivation of the potato crop in particular was gained.

### *Virus Diseases—Craigs House.*

G. Cockerham, B.Sc., Ph.D.
T. M. R. M'Ghee, B.Sc., N.D.D.

The progress made in breeding for resistance to potato viruses has raised problems of providing, in the near future,

efficient and rapid tests for the estimation of resistant characters. Hitherto tests for field immunity (viruses X, B, A, C, and Y) have been made exclusively by graft transmissions requiring a considerable amount of infected material for scions and a period of months for the completion of the tests by recovery of virus from susceptible varieties. By replacing the grafting test with one of leaf inoculation wherever possible, and by using serological tests for recovery of the X viruses, it has been found possible to reduce the time and space requirements and so to increase greatly the amount of material which can be handled in each season. The anti-X serum used in the serological tests was prepared in co-operation with Dr J. G. Carr, Institute of Animal Genetics, The University, Edinburgh.

The problem of testing for resistance to leaf-roll is of a different type. There is no sharp differentiation between susceptibility and resistance, and the only adequate form of test at present available is one of comparison between seedling varieties under exposure to infection in the field. Such tests require large numbers of tubers, and on considerations of space alone they cannot be applied to seedling material for the purpose of selection at an early stage or for genetical studies. The problem of leaf-roll resistance, therefore, is being examined from the point of view of establishing the most efficient form of trial for obtaining adequate data on comparative resistance from a minimum number of tubers in a minimum period of time. With this objective several different forms of trial were laid down for the purpose of obtaining preliminary information on their comparative efficiencies.

General studies on the nature and inheritance of resistance of potato viruses were continued. A previously suspected immunity from virus Y of the non-susceptible type and found in a variety of *Solanum rybinii* has been confirmed. The inheritance of this character and that of hypersensitiveness to virus Y was studied in seedling progenies of diploid parentage.

Other genetical studies on linkage relationships and on the relationship between genes determining field immunity from different strains of viruses were carried a stage further.

Several progenies of parentage involving species of different chromosome numbers were raised. Many of the individual plants in these progenies were unproductive of tubers when grown in the field, but this and many other " wild " characteristics have been eliminated by further hybridising with commercial varieties. Upon test some of these seedlings have

been found to be immune from two or more strains of blight, field immune from viruses X, A, C, and Y, and to possess resistance to leaf-roll.

With the assistance of Mr N. R. Nobrega of São Paulo, Brazil, during his tenure of a British Council Scholarship, studies were initiated into the problems of virus strains. The first objective was a survey of the strains of viruses X and Y to be found in Scottish potato stocks. The examination of 160 sources of virus X, selected from material showing a wide variation of symptoms in 1946, has proved that the problem of differentiating strains is extraordinarily complex. Very few sources were found to contain single strains of the virus, and although in many cases it was clear that simple mixtures were present there are indications of instability of the virus—that is, of an inherent capacity for mutation. With the exception of virus B, however, no strain has yet been found which fails to invoke the gene Nx—that is, all varieties which possess this gene and the gene Nb are field immune from all the recorded strains of virus X.

In the survey of plants infected with virus Y, differences in symptom expression appeared to be due either to differences in varietal response or to differences in the strain of virus X where this virus was present in mixed infections. There was no indication of more than one strain of virus Y in the sources examined.

A preliminary trial of the effects of virus X on yield provided the unexpected result that infections with mild strains of the virus in two varieties, Majestic and Kerr's Pink, led to higher yield than in the uninfected controls. It is believed that this result was due to the abnormally dry season, which led to premature ripening and so affected yields generally.

The weather during the year also showed its effect in aphis populations. The first record of aphides was made on 21st July, six to eight weeks later than is usual. Populations built up rapidly during August, however, and a maximum index of 1290 was obtained on 12th September.

## *Herbage Plants.*

J. W. Gregor, Ph.D., D.Sc., F.L.S.
Patricia J. Watson, M.A.

*Complementary Pastures.*—One of the agronomic objectives of the practical breeding programme is the improvement of the

diet of animals feeding on rough uncultivated grazings, and in particular to explore the possibilities of creating conditions which would allow the breeding populations of cattle in the essentially grassland districts of Scotland to be increased. As indicated in previous reports the idea is to supplement the diet of animals feeding on low-quality roughage by allowing them access to very protein-rich cultivated pasture for a short time each day. Theoretically such a joint use of contrasting types of vegetation should make it possible to increase grass production per arable acre to the limit of plant response to intensive manurial treatment without detriment to the grazing animal, and at the same time convert inferior roughage into a useful, instead of regrettable, constituent of diet. The experiments being conducted along these lines show that both yields of dry matter per acre and percentages of crude protein in the dry matter can be raised to exceptionally high levels by the appropriate choice and treatment of herbage plants. Moreover, the fact that this rich diet is used to supplement a basic diet of hill herbage means that a small acreage of arable grass can be used to feed a large number of animals. The initial problem is to find grasses capable of producing a protein-rich and productive herbage at the times supplementary feeding is most needed. Naturally these times vary from locality to locality and according to the botanical composition of the complementary rough vegetation.

With the exception of the mild winter of 1945-46, when certain strains of ryegrass gave a reasonably good response to nitrogen applied in late December, the results from the winter-grazing trials have been decidedly disappointing, since the percentage of winter killing has been high—in one instance as high as 85 per cent. Although work on winter-active grasses has not been abandoned, it is felt that the most reliable way of dealing with the winter needs of hill stock is to conserve summer grass either as hay or silage, and accordingly attention is being given to finding strains which will not only fit a programme of spring and autumn complementary grazing, but be ready for cutting at the time labour is available.

The value of autumn grazing as complementary feed is dependent to a considerable extent on whether the summer crop has been cut for hay or for silage. For example, the percentages of crude protein in the dry matter of samples of a late variety of ryegrass collected on 27th August were 17 and

26 for the aftermaths of hay and silage crops respectively. This difference in the quality of the grazing was due to the greater amount of withered material present in the hay stubble.

As far as spring production is concerned, the aim is to supply high-yielding and protein-rich pasture from the middle of April until the hill grasses start active growth. In meeting the needs of stock at this critical period of the year, account has been taken of the fact that protein percentages fall as the plant develops towards maturity. For example, the percentage protein in the dry matter of an early-developing strain of ryegrass was 17 on 31st May, while on the same day that of a late strain was 29. By way of comparison, the corresponding value for the adjoining hill vegetation averaged 11 per cent. In order to maintain high-protein values consistently throughout the period of spring grazing it has been found necessary to segregate early, mid-season, and late strains and to graze them in that order. Under the intensive nitrogen treatment competition between grasses and leguminous species is severe, and even a strong-growing white clover like S100 has contributed little to the spring herbage (0.3 per cent of the dry matter).

While the complementary use of cultivated pasture is primarily dependent on maintaining protein percentages in excess of the hill grazing, really high *yields* of protein are also essential to the successful application of this system; for a small acreage of intensively cultivated grass must be capable of giving part-time feed to as many animals as possible, a point which will become increasingly important in districts where forestry is absorbing some of the better-class rough grazing. Thus in addition to a grass strain providing a protein-rich diet at the appropriate time it must also yield a large amount of protein per acre.

On some farms it might be an advantage to extend the complementary grazing period throughout the summer months as is done at the Dalmahoy trial centre. For this purpose there is a possibility of making use of natural herbage, with a short summer productive season only, instead of cultivated grass, and so free the arable acreage for a silage crop. In this connection a preliminary examination of the response of selected *Agrostis* swards to intensive nitrogen treatment has been undertaken. It is, however, evident that *Agrostis*, like

the cultivated grass species, comprises races of very different agricultural value. The probability is that forms growing at the higher elevations would not respond to nitrogen sufficiently to make intensive treatment worth while, and until information regarding the altitudinal distributions of variation in common bent is available, it is impossible to give even an approximate answer to this question. A more detailed account of the results obtained during the past year can be found in the April issue of ' Scottish Agriculture.'

The arrangement under which Mr W. D. Connell has carried out, at the Edinburgh and East of Scotland College of Agriculture, all the chemical analyses connected with the herbage research programme has worked very smoothly and efficiently.

Opportunity is taken here to thank Mr Andrew Howie, B.Sc., County Organiser for Ross-shire, for supervising the making of grass silage at the Dundonnell Centre, and Mr John Macleod, Farm Manager, Dundonnell, for his help in carrying out the experimental programme.

*Regional Race Investigations.*—In Scottish agriculture seed from regional races which have developed under the selective influences of climate and of agronomic practices is extensively used. The current tendency to certify regional stocks is a welcome indication of the desire to maintain, and in some cases to improve, the characteristics of useful races. The study of the hereditary composition of regional races and the factors responsible for their development have received comparatively little attention from plant breeders, yet it is largely upon such information that the effectiveness of certification depends.

In last year's report it was mentioned that the perennial ryegrass population of Devon, Cornwall, and the Scilly Isles had been sampled mainly in the hope of locating desirable early types for breeding purposes, but also to supply the local seed growers' associations with the information required for the multiplication of useful and reliable certified stocks. Even at this early stage of the investigation it is quite apparent that this regional population comprises many local subpopulations of very different hereditary constitution.

*The Multiplication of Bred Strains.*—Twenty-five acres of Scotia cocksfoot were seeded under contract in Essex in 1947 and 53 cwt. 3 qr. 4 lb. of clean seed were sold to members of the Society.

Arrangements were made to have stock-seed plots of Scotia cocksfoot, Scotia timothy, and perennial ryegrass *Ca* 461, and seeds of these were sown in Lincolnshire in 1947.

At Corstorphine two strains of perennial ryegrass have been multiplied in sufficient quantity for sowing in initial field trials, while a strain of early cocksfoot and an American variety of tall fescue, Kentucky 31, are in process of being multiplied for future trial.

## Root Crops.

V. M'M. Davey, B.Sc., Ph.D.

### *Swedes, Kales, and Mangolds.*

This year saw the resumption on the pre-war scale of yield trials for the evaluation of swede strains and of clubroot resistance tests. The collection of swede types was maintained and propagated by self-fertilisation, and selection of strains from intervarietal hybridisation was continued. Selection of parent plants by dry-matter content, which has shown low efficiency when followed by inbreeding, was used to obtain groups of plants of similar type which were subsequently mass-propagated. Despite late sowing, good crops were obtained, though the dry summer favoured the attacks of clubroot in parts of the trial grounds. Some kale strains were tested in a trial and others were propagated. The number of isolation plots was increased this spring to ten, through the generosity of farmer members and of the Edinburgh Agricultural Centre at Boghall and The Bush Estate in providing suitable sites.

*Yield Trials.*—Twenty-five Station strains of swede and commercial controls were tested in a trial. The actual yields were at the following rates :—

| | Mean. | Range. |
|---|---|---|
| Dry-matter per acre . . | 57 cwt. | 63-40 cwt. |
| Dry-matter percentage . . | 10.3% | 12-9% |
| Gross yield per acre . . . | 28 tons | 32-17 tons |

Three varieties were used as standards for maturity types

and when the mean value for the trial was taken as 100 their relative values were :—

| | 1st Early (Victory). | Maincrop (Champion). | Late (Aberdeen). |
|---|---|---|---|
| Dry-matter yield . . | 110 | 102 | 85 |
| Dry-matter percentage . | 97 | 104 | 101 |
| Gross yield . . . | 113 | 98 | 84 |

The late type, an Aberdeenshire variety, was a partial failure. Conditions at the Station are seldom suitable for this type, and it was also lifted before its optimum period.

Among the early types an inbred line, DNe—, gave the highest gross yield, 116, and had a dry-matter yield of 104, which was good but no better than its parent variety, Dreadnought, which yielded 106 in this respect. An old Station, strain, ABJ or Ds 27, had a gross yield of 111 and dry-matter content 107.

Individual dry-matter tests had been employed to separate two groups of plants from the segregating generation of a cross. One group had large bulbs and average dry-matter percentage and the other showed the highest dry-matter percentages. The groups were seeded in different isolation plots and their progenies yielded as follows :—

| | Large bulb group. | High dry-matter group. |
|---|---|---|
| Dry-matter yield . . . | 108 | 99 |
| Dry-matter percentage . . | 97 | 98 |
| Gross yield . . . . | 111 | 101 |

Selection for size had shown an effect, but there was no response to dry-matter selection, probably because both parents were too similar in type, both being early.

Relatively high dry-matter percentages were shown in two hybrid strains which each had a Danish Bangholm ancestor. Strain AMU*aa* had 104 for both percentage and yield of dry matter, while strain ANF*aa* had a high percentage, 109, but yielded poorly, so that the yield of dry matter was only average.

A hybrid strain, AMH, from a cross between swede and rape-kale was included in the trial. Its dry-matter percentage was very high, 118, or in actual value 12.1 per cent, but its yield was only 60. This strain has closely curled leaves like

Hungry-gap kale and a swede-like bulb. From a single test it would appear that the proportions of soluble and insoluble solids were similar to those found in true swedes. Further breeding would probably increase the bulb weight.

*Winter Resistance Trial.*—The swede × rape-kale hybrid mentioned above was also included in this trial. Its dry-matter percentage was 13.9, and stood at 121 in relation to the trial mean, but the yield was again very low at 63. Despite the hardness of the roots, resistance to frost was relatively poor.

Of the nine swede strains in the trial, AFT or DS 32, derived from a cross between Buffalo × Stirling Castle, again showed the best winter resistance, and also had the best yield of dry-matter in October, due to high gross yield and average dry-matter percentage. A pedigree line, CHo, had better winter resistance than its parent variety, Champion, which it equalled in dry-matter yield, taking third place after AFT and Victory. Another hybrid strain, AHQ, from Champion × a Station strain, also showed good resistance, and yielded slightly above average.

The test differed from those of the past few years in that the hard frosts occurred before Christmas, though not before the first part of the trial had been tested and weighed.

*Clubroot Resistance.*—The number of tests was increased to over sixty boxes, each starting with sixty-three seedlings. It was found that top-dressings of gammexane applied at ten-day intervals almost completely suppressed the maggots of cabbage root-fly without affecting the clubroot organism. Previously the roots of many seedlings were too mutilated for the observation of nodules. Comparison of strains of swede was made on single rows randomised through a series of boxes, and rows of Bruce turnip and rape were used as controls. These usually showed complete resistance and high susceptibility respectively, but the rape was apt to grow too vigorously and to stunt the adjacent plants.

*Kale Trial.*—Some strains derived from the hybridisation of Perpetual × Curly kale were tested along with a few Thousand-headed strains and a Curly kale. The leaf curl of the hybrids was intermediate and somewhat closer than that shown by Hungry-gap kale. One or two of the hybrid strains had good yields of leafage and wide ratios of leaf : stem in the autumn, but there was little growth of fresh leaves during

the winter. Thus the average leaf weight per plant fell from 36 oz. in autumn to 22 oz. in spring. The Curly kale behaved similarly, dropping from 46 to 21 oz. The Thousand-headed kales, however, averaged 44 oz. per plant in autumn and 40 oz. in spring.

*Propagation.*—Sufficient seed was obtained in 1947 to sow out trials and observation plots in 1948. Selections were made from all the more promising strains for seeding by self-fertilisation, and selected groups of swedes and kales have been planted out in isolation plots for mass propagation.

## *Broccoli.*

Ten pounds of seed were obtained in 1947 from a small crop of the Station strain, 9 : 3, broccoli, which had escaped the full severity of the winter. A rather larger area of the strain was planted out for seeding in 1948. The progenies of selected mother plants were used, and inferior types will be removed before seeding. The 1947 trials also consisted of these progenies, and although the crop had to be ploughed up because of damage by pigeons, a few of the best plants were kept and intercrossed in the greenhouse. Two plots of broccoli strains received from the National Institute of Agricultural Botany, Cambridge, have been grown for observation in 1948.

## *Sugar Beet.*

Preparations were commenced in anticipation of a scheme of work with sugar beet which has now come into operation. It was decided to start with two lines of investigation : (1) the search for non-bolting strains of true sugar beet, and (2) inquiries into the possible use of heavy-cropping forms of beet for sugar production on upland farms. The main purpose of the breeding programme, the production of a distinct variety suited to Scottish conditions, has always to be kept in mind.

*Resistance to Bolting.*—Seed of four good sugar-beet varieties was sown out in March in a nursery plot. The plants will be observed individually, their behaviour noted, and any particularly good specimens will be kept for propagation. After

this trial had been laid down, the Station received a gift of forty-three small samples of sugar beet seed of lines selected by artificial-light treatment from Dr G. D. H. Bell of the Cambridge Plant-Breeding Institute, and these have been sown in a field-trial plot.

*Heavy Cropping Forms.*—A yield trial containing three varieties of fodder sugar beet, three of true sugar beet, and two of mangolds has been sown out with a view to determine the performance of fodder beet in respect of feeding value when compared with mangolds and as a source of sugar when compared with sugar beet.

## II. Publications and Lectures by Staff for the Year ended 31st March 1948.

**Publications (P) and Lectures (L).**

Director of Research.

" Research and the Farmer. VI. Plant Breeding." Scottish Agriculture, Vol. XXVII., No. 3, 1948. (P.)

William Black, B.Sc., Ph.D.

" Latest Developments in Potato Growing in Britain." Script for B.B.C. Latin-American Service. (L.)

" Recent Developments in Potato Breeding." Meeting of Agricultural Education Association, College of Agriculture, Edinburgh. (Published in ' Agricultural Progress.') (L. and P.)

" Potato Breeding in Britain." Britanskyi Soyuznik, H.M. Embassy, Moscow. (P.)

" Blight Resistance in Potatoes." Agriculture, Vol. LIV., No. 5. (P.)

" Potato Breeding." East Lothian Agricultural Discussion Society. (L.)

" Disease Resistance in Potatoes." Farming, Vol. I., No. 11. (P.)

"Blight in Relation to Potato Breeding." Association of Applied Biologists (Published in 'Annals of Applied Biology,' Vol. XXXIV., No. 4, 1947). (L. and P.)

"Research and the Farmer—Potatoes." B.B.C. Discussion. (L.)

William Black and J. C. Haigh, B.Sc., Ph.D., A.R.C.S.

"Strains of Potato Blight in Scotland." Scottish Agriculture, Vol. XXVII., No. 1. (P.)

George Cockerham, B.Sc., Ph.D.

"Potato Breeding." Strathmore Young Farmers' Club, Meigle. (L.)

"The Inheritance of Disease Resistance in Potatoes." Research Staff, Hungarian Ministry of Agriculture. (L.)

"Resistance to Potato Viruses." Agricultural University, Budapest. (L.)

"Potato Breeding for Disease Resistance." Plant-Breeding Institute, Mosonmagyarovar. (L.)

"Potato Viruses." Agricultural University, Mosonmagyarovar. (L.)

J. W. Gregor, Ph.D., D.Sc., F.L.S.

"*Phleum alpinum* L. emend. Gaud. and *P. commutatum* Gaud." Trans. Bot. Soc. Edinb., Vol. XXXIV., 1947. (P.)

"'S' Strains." Notes for Farmers, Vol. 8, No. 17. (P.)

Contribution to B.B.C. programme, "Dundonnell Report." (L.)

J. W. Gregor and W. D. Connell.

"Grass as a Protein Concentrate for Complementary Grazing." Scottish Agriculture, Vol. XXVII., No. 4, 1948. (P.)

J. W. Gregor, in collaboration with H. A. Rendel Goven, A.R.I.B.A.

"Trends in Agriculture." Assoc. Scientific Workers, Edinburgh. (L.)

## III. Visits.

Director of Research :—

National Institute of Agricultural Botany, Cambridge.

William Black, B.Sc., Ph.D.

" Lord Derby Gold Medal Trials " at Hutton Farm Institute, Preston.
Plant-Breeding Conference, Cambridge.
Tanganyika and Kenya.

George Cockerham, B.Sc., Ph.D.

Fourth International Congress for Microbiology, Copenhagen, Denmark.
Plant Pathology Station, Lyngby, Denmark.
Plant Virus Research Station, Holte, Denmark.
Agricultural Experimental Station, Åkarp, Sweden.
Weibull's Plant-Breeding Institute, Landskrona, Sweden.
Plant-Breeding Station, Svalöf, Sweden.
Agricultural Experimental Station, Ugerup, Sweden.
Plant Protection Institute, Stockholm, Sweden.
Institute for Plant Research and Cold Storage, Nynäshamn, Sweden.
Agricultural High School, Umeå, Sweden.
Laboratory for Bulb Research, Lisse, Holland.
Laboratory for Mycology and Potato Research, Wageningen, Holland.
Seed Potato Farms, Strathallan Castle, Auchterarder.
Rothamsted Experimental Station, Harpenden, Herts.
Plant Virus Research Unit, Cambridge.
Various Research Institutes in Hungary.
Genetics Institute, Charles University, Prague, Czechoslovakia.
Plant Pathology Department, Technical University, Prague, Czechoslovakia.
Raspberry Diseases Investigations, University College, Dundee.

V. M'M. Davey, B.Sc., Ph.D.

British Sugar Corporation, Ltd., Beet Sugar Factory, Cupar, and trials in Fife.
Plant-Breeding Conference, School of Agriculture, Cambridge.

J. W. Gregor, Ph.D., D.Sc., F.L.S.

Welsh Plant-Breeding Station, Aberystwyth.
Plant-Breeding Institute, Cambridge.
National Institute of Agricultural Botany, Cambridge.

T. M. R. M'Ghee, B.Sc., N.D.D.

Plant Breeders' Conference, Cambridge.
Plant Virus Research Unit, Cambridge.

D. Cameron, B.Sc., J. C. Haigh, B.Sc., Ph.D., A.R.C.S., and P. J. Watson, M.A.

Plant Breeders' Conference, Cambridge.

## IV. Acknowledgments.

Grateful acknowledgment is made to the undernoted departments, institutes, firms, and individuals for facilities for carrying out experiments and for gifts of samples or other material :—

Agricultural Experiment Station, Kentville, Nova Scotia.
Åkerman, A., Plant-Breeding Station, Svalöf, Sweden.
Alexander, T. G., Newton, Garmouth, Morayshire.
Allison, William, Almond Hill, Kirkliston.
Barclay, Ross & Hutchison, 67 Green, Aberdeen.
Bell, David, 15 Coburg Street, Leith.
British Sugar Corporation, Ltd., Cupar and Peterborough.
Carr, J. G., Institute of Animal Genetics, King's Buildings, West Mains Road, Edinburgh.
Central Agricultural Experiment Station, Sofia, Bulgaria.
Clausen, Jens, Carnegie Institute of Washington, Stanford University, California.
Commonwealth Agricultural Bureau, Cambridge (per P. S. Hudson, J. G. Hawkes, and R. W. G. Wortley).
Dale, John R., Auldhame, North Berwick.

Department of Agriculture for Scotland (per T. M'Intosh, C. E. Foister, J. L. Hardie, M. Noble, and James Mitchell).

Edinburgh and East of Scotland College of Agriculture, Edinburgh (per A. M. Smith, A. S. B. Wilson).

Elder, James H., Cregganore, North Berwick.

Findlay, W. M., Agriculture Department, Marischal College, Aberdeen.

Gartons, Ltd., Warrington (per T. E. Miln).

Henderson, R. M., & Co., 61 Albert Street, Edinburgh.

Hutton, E. M., Council for Scientific and Industrial Research, Australia.

John Innes Horticultural Institution, Mostyn Road, Merton Park, London (per M. B. Crane and Gordon Haskell).

Landbo- og Husmandsforeningernes, Roskilde, Denmark (per K. J. Frandsen).

Maček, Jan, Genetics Institute, Charles University, Prague, II., Vinicna 5, Czechoslovakia.

National Institute of Agricultural Botany, Cambridge (per F. R. Horne and E. G. Thompson).

Neptune Mills, Ltd., Charlotte Street, Leith.

Olsson & Sons, Hammenhög, Sweden.

Petrie, G. G., Inchbroom, Elgin.

Phytotechnical Institute, Buenos Aires, Argentina (per E. C. Clos).

Phytosanitary Institute, Budapest, Hungary (per T. Jermy).

Plant-Breeding Institute, Wageningen, Holland (per C. Bakker).

Plant-Breeding Institute, Cambridge (per G. D. H. Bell).

Plant Research and Cold Storage Institute, Nynashämn, Sweden (per B. Emilsson).

Plant Protection Institute, Stockholm, Sweden (per D. Lihnell).

Plant Pathology Department, Rothamsted (per F. C. Bawden).

Plant Virus Research Unit, Cambridge (per R. E. F. Matthews.)

Plant Pathology Station, Instituto Biologico, São Paulo, Brazil (per N. R. Nobrega).

Plant Pathology Department, University of Wisconsin, U.S.A. (per R. H. Larsen).
Roberts, Sir James Denby, Bt., Strathallan Castle, Auchterarder.
Royal Danish Agricultural High School, Rolighedsvej 26, Copenhagen, Denmark.
Ryksstation voor Plantenveredeling, Melle, Belgium.
Smith, W., & Son, Ltd., Market Street, Aberdeen.
Twyford Mill, Ltd., Adderbury, Banbury, Oxon. (per G. Scott).
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Webb, Edward, & Son (Stourbridge), Ltd., Wordsley, Stourbridge, Worcs. (per T. M'Cormick).
Welsh Plant-Breeding Station, Aberystwyth (per Gwilym Evans and E. T. Jones).
Weibulls, W., A-B., Weibullsholm, Landskrona, Sweden.
West of Scotland Agricultural College, Auchincruive (per John Macfarlan and J. Grainger).
Wilson, A. Gordon, Old Crombie, Bridge of Marnoch, Huntly.
Young, James, Meadowfield, Corstorphine, Edinburgh.

## V. Student Workers.

Mr N. R. Nobrega, Instituto Biologico, São Paulo, Brazil, assisted in the work of the Potato Virus Diseases Section during his tenure of a British Council Scholarship which ended on 6th September 1947.

Mr A. Ganguly, B.Sc., has been engaged in post-graduate research in the Potato Virus Diseases Section since October 1947 after an initial period of training.

WILLIAM ROBB,
*Director of Research.*

# ESTABLISHMENT FOR 1948-49.

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*Printed by William Blackwood & Sons Ltd., Edinburgh.*