1936

REPORT

BY

DIRECTOR OF RESEARCH.

I. Research Programme.

The aim of the Society is to promote research for the improvement of plants and crops in Scotland, and breeding experiments are being carried out on Grain, Potatoes, Herbage (Perennial Ryegrass, Cocksfoot, Timothy, and Plantain), and Swedes. The search for superior varieties of the above-mentioned crops continues, and a review of the year's work at the Scottish Plant-Breeding Station is given in these pages.

A. Grain Crops.

Oats.

As breeding for resistance to lodging is an important part of the oat programme, many hybrid oat selections which had given indications of being resistant were grown for comparison. Among the more promising of those which are in the most advanced stages of development there are derivatives of the undernoted crosses :—

Potato × Yielder ;
Castleton Potato × Yielder ;
Hybrid, Elder type × un-named early ripening hybrid.

While the weather conditions at Corstorphine in 1935 were not favourable to the production of lodged crops, and, consequently, little could be gleaned concerning relative powers of resistance to lodging, other comparisons could be made, and various selections were eliminated on account of certain deficiencies such as in yield and in quality of grain. Several promising selections having short straw, maturing earlier than the Elder variety, and giving indication of being highly productive, have been retained for further trial. A series of Elder × Orion fourth-generation hybrids was grown, and this group contained some early-ripening plants having the Elder type of straw. It was observed, however, that this was the only series of hybrids which suffered extensive damage by eelworm. Damage by this soil pest has occurred in the same field before, but as various other hybrids growing alongside were not appreciably damaged at all, it is probable that many of the plants in this series were very susceptible to attack. A few plants throughout the affected plot, which showed no signs of injury, were retained for further observation, particularly to see whether susceptibility to eelworm attack is again indicated.

The summers of 1934 and 1935 were comparatively dry, and in many oat crops 'blind' or barren spikelets were prevalent, some varieties apparently being liable to suffer extensively from this defect. It has been shown by Canadian workers that this condition may result from the effects of drought on the growing plants. Since the tendency to form these blind spikelets under unfavourable environmental conditions appears to be a hereditary character, it should be possible to breed new varieties which are practically free from the tendency. It was therefore of interest to find among the hybrid oat progenies in 1935 marked differences in the proportions of barren spikelets produced. Several selections from one cross were practically free from the trouble, while some from other crosses grown alongside were markedly affected. Those selections which seemed to be resistant to the trouble, and which also showed promise in other ways, were marked for further multiplication.

In view of the value of the huskless oats for feeding poultry, the question of developing varieties of the huskless oat specially adapted to Scottish conditions has been receiving attention. The Canadian huskless varieties, Laurel and Liberty, have

been under observation at the Station for several years, but they do not seem well adapted to conditions here. They are both early ripening, but they have not given a sufficiently high yield of grain to enable them to compare favourably on a financial basis with the ordinary husked varieties. Since better varieties may be obtained by hybridisation a few crosses between ordinary and huskless oats have been made, and selections from their progenies have been taken for study.

There was a keen demand for seed of Early Miller oats for sowing in 1935, and it was decided that the Society should grow on contract in 1935 about 68 acres of these oats for seed. This acreage was grown by four farmers—two in Midlothian, one in East Lothian, and one in West Lothian. On all farms excellent crops were obtained, and heavy yields of attractive grain, especially for milling, were produced. The heaviest yield was obtained in West Lothian, where, from 26 acres, a yield of over 35 cwt. per acre of dressed grain, weighing about 47 lb. per bushel, was secured. All the Early Miller grain was brought to Craigs House to be cleaned by the new grain-cleaning machinery recently installed. This machine is one of the latest, designed by Messrs R. Boby, Ltd., Bury St Edmunds. It is driven by an electric motor, and it dresses the grain very efficiently. Members of the Society were invited to apply for the grain, which was offered at 12s. per cwt. free on rail Corstorphine, and in all about 52 tons were disposed of for seed. The remainder was readily sold for feeding purposes.

Foundation stocks of each of the three of the Society's new oats, Elder, Bell, and Early Miller, will be retained at the Plant-Breeding Station, and these will be multiplied when required. In connection with this part of the work in growing foundation stocks, it would be very helpful if members of the Society could indicate their probable requirements of seed of these considerably in advance of the time when the seed is required.

Barley.

Grain from the single plant selections of Common Scotch barley secured in 1934 was sown in five-foot rows in 1935. The grain from individual plants was, of course, sown separately in the rows, each row representing one selection. This

lining of the selections helped in distinguishing the different forms. A representative collection of types was retained, and seed from those will be included in future trials at the Plant-Breeding Station. All the selections appeared to be true breeding, and it only remains to select and multiply the most promising lines for further comparison in the North of Scotland.

An awnless six-rowed barley, which has comparatively short straw, has been crossed successfully with some of the two-rowed cultivated barleys. The progenies of these crosses will, it is expected, provide interesting material for study. The work on barley has been undertaken by Mr J. M. S. Lang, Junior Assistant.

Beans.

The initial selections taken in 1934 from several varieties of field beans (*F. vulgaris*) were lined, and further comparisons and selections were made with a view to seeing whether any improved types can be secured by selection from common commercial varieties.

The possibility of introducing new crop plants in Scotland is being kept in view. The Soya bean has many uses, and is an important crop in many countries. Samples of six varieties of Soya beans, four of which seem to have been giving promising results in the South of England, were sown in small observation plots at Corstorphine. The seeds before being sown in the plots were inoculated with a culture of the appropriate nodule-forming organism, as the presence of this organism is necessary to promote the full development of the Soya bean plant. Two varieties grew rather more vigorously than the others, but all produced light crops. The wet weather in September and October appeared to be unfavourable for the development of these beans, and little growth was made after the middle of September. Very few nodules appeared on the roots of the plants grown in the field, but nodules were present in considerable numbers on the roots of the plants grown from inoculated seed sown in pots. Plants from non-inoculated seed grown in pots had no root nodules. Sufficient seed was obtained from all the six varieties for sowing in small plots in 1936.

B. Potatoes.

Assistant in Charge—William Black, B.Sc., Ph.D. (Ainville Sub-Station).

An increased proportion of seedling progenies bred from wild tuber-bearing species of *Solanaceæ* was raised in 1935. These seedlings were secured chiefly by inter-specific hybridisation and by back-crossing. The species employed included representatives of each of the diploid, triploid, tetraploid, and hexaploid chromosome groups, but chief interest has centred round three species—viz., *S. demissum*, *S. andigenum*, and *S. rybinii*—on account of special characters which they possess. The outstanding feature of *S. demissum* is its resistance to blight; it is also frost tolerant. *S. andigenum* is, with the exception of *S. tuberosum*, the largest and most prolific tuber-bearing species, and probably possesses even greater varietal diversity than *S. tuberosum*. *S. rybinii* is reputed to show resistance to virus diseases. These three species cross quite readily with cultivated potato varieties, although with the hexaploid *S. demissum* success can be achieved only when the latter is used as female parent.

The first generation hybrids between wild species and cultivated varieties invariably bore a greater resemblance to the wild than to the cultivated parent, and showed no immediate promise as types of commercial value. On their being back-crossed with the cultivated variety, however, a wide range of segregation was apparent and many interesting and more promising forms were obtained. In general, some progress towards a type of greater economic value was observed with each successive back-cross, plants possessing tubers of good size and shape frequently appearing. It is intended to continue back-crossing the more promising plants with cultivated varieties, and to test certain progenies for resistance to blight under controlled conditions in order to facilitate the selection of further breeding stock.

Observations were again made on the effects of repeated self-fertilisation of varieties and of inter-crossing selfed lines. Several of the lines have now reached the eighth inbred generation. Some of the lines have remained strong and vigorous, but others have become weak and lack vigour. Hereditary degenerate plants were observed to be more

numerous than in previous generations, and these were frequent in the less vigorous lines, several of which contained between 20 and 25 per cent of such plants.

The seedlings from crosses between commercial varieties contained some promising plants, and the best were retained for further trial. Progenies derived from Arran Pilot × The Alness, Dunbar Cavalier × The Alness, and Eclipse × Majestic were of special interest. The last-mentioned family contained many seedlings having fine kidney-shaped tubers.

The more successful combinations of parent varieties, as shown by the second-year seedlings, were Abundance × Pepo, Arran Comrade × The Alness, Catriona × Herald, Catriona × 188*a*(91), Golden Wonder × Pepo, Kerr's Pink × The Alness, Kerr's Pink × Pepo, and Majestic × The Alness. All the older seedlings in the more advanced stages of test were grown in trial and multiplication plots. Samples of the majority of seedlings undergoing test as prospective commercial types were also included in trials at other centres—*e.g.*, Craigs House; Department of Agriculture for Scotland, East Craigs; and Ormskirk, Lancashire.

Five seedling varieties were included in the Wart Disease Immunity Trials carried out by the Ministry of Agriculture and Fisheries at Ormskirk: four in the second-year test and one in the first. Favourable reports were received in respect of four of them.

Three of the Society's seedlings which were included in the Registration Trials conducted by the Department of Agriculture for Scotland in 1935 have been recommended for further trial; two of them—viz., 134(5) and 316*a*(4)—in the second-year trial; and the other—viz., 967*c*(38)—in the final-year trial in 1936. The last-mentioned is a maincrop variety characterised in the field by a high degree of resistance to blight (*Phytophthora infestans*) in its foliage.

A further group of seven new seedlings have been selected for official trials in 1936. Five of them—viz., 134(139), 139*a*(67), 318(38), 322(4), and 398*a*(19)—will be included in the First Year Registration Trial of the Department of Agriculture for Scotland, and the remaining two—viz., 188*a*(70) and 317*a*(3)—in the Wart Disease Immunity Trials conducted by the Ministry of Agriculture and Fisheries at Ormskirk. A brief description of all the above-mentioned varieties is given in Table I.

TABLE I.

Reference Number.	Parentage.	Maturity.	Tuber.		Cooking Quality.
			Shape.	Colour.	
967*c*(38)	Bishop × 800(2)	Maincrop	Oval	White	Very Good
134(5)	Abundance × Flourball	1st-Early	Oval	White	Good
316*a*(4)	British Queen × The Alness	Early-Maincrop	Oval	White	Very Good
134(139)	Abundance × Flourball	1st-Early	Oval	White	Good
139*a*(67)	Bishop × Flourball	Early-Maincrop	Oval	White	Good
318(38)	May Queen × 121(2)	1st-Early	Oval	White	Good
322(4)	966*f*(1) × Herald	Maincrop	Kidney	White	Very Good
398*a*(19)	Up-to-Date × The Alness	2nd-Early	Oval	White	Very Good
188*a*(70)	Majestic × 120(3)	Early-Maincrop	Oval	Pink Flush	Good
317*a*(3)	Kerr's Pink × Herald	Early-Maincrop	Kidney	White	Very Good

The Society's new potato variety, The Alness, was further multiplied in 1935 under arrangements made with Mr John Chisholm, Gibston, Huntly. About 1¾ acres were planted, and a Stock Seed Report in respect of the crop was granted by the Department of Agriculture for Scotland. The seed tubers in the produce were offered to members of the Society in January 1936 at £12 per ton, and 8 tons 7 cwt. were sold as seed to members.

Part of the potato-breeding work in 1935 was undertaken at Gibston, Huntly, and the remainder at Ainville, Kirknewton.

In view of the Directors of the Society having decided to discontinue their breeding work with potatoes at Gibston, Huntly, all the Society's buildings have been removed from there to Ainville, Kirknewton, where all the breeding work with potatoes will in future be conducted.

C. Herbage Plants.

Assistant in Charge—J. W. Gregor, Ph.D., F.L.S.

Investigations have been continued with a view to (1) producing strains of pasture plants suitable for sowing on poor land of potential fertility to increase its productivity, (2) raising of pasture strains suitable for the environments of high fertility pastures, and (3) studying special problems relating to the breeding and the utilisation of pasture plants.

The major problem at present is not so much the search for new pasture species as the study of races and growth-types within species. Such races and types form the foundation of specialised agricultural strains. For the past few years the critical study of the composition and distribution of certain races of grasses and plantains has been carried out at Corstorphine, and now an attempt is being made to correlate the characters exhibited by local races with the environmental conditions prevailing in the region where they flourish. In pasture work (especially when renovating poor pasture) this question of racial preference is an important one, because unless the sown plants can survive the climate, compete with the natural grasses and weeds, and be capable of withstanding the attacks of grazing animals, a good pasture will soon be replaced by one of lower palatability and nutritional value. In Scotland environmental conditions differ much from district to district, and a pasture strain which does well in one district or under one system of farming practice may prove to be of little value under other conditions. Racial differences, however, are frequently quantitative in character and vary continuously—*i.e.*, no recognisable gaps appear in the series of types. Through utilising many populations of plantains (*P. maritima*) various methods for the identification of racial differences have been examined at this station, and the results of the investigations will be published in the 'New Phytologist.'

The article referred to deals with methods of studying quantitative characters and variability of races under the comparatively uniform conditions of an experimental garden. Investigations were made regarding methods of sampling local races and of arranging the samples in the garden, the choice of characters for comparison, the sampling of individual plants, the examination of errors (sampling, &c.) due to non-hereditary causes, and the formulation of methods of assessing the character values of populations. These investigations have been carried out in conjunction with an intensive study of races collected from different environmental regions, and form an introduction to a series of articles on that subject. Two main considerations have dictated the use of sea-plantains for these studies: (1) to secure a clear view of the potentialities of local races it was desirable to employ a species which had not been indiscriminately disturbed in the practice of agriculture, and (2) there was a possibility that the sea-plantain might be found capable of adoption for agricultural purposes.

Timothy.—A large collection of types of this species have been examined during the last few years. The material includes both 'diploid' (14 chromosomes) and 'hexaploid' (42 chromosomes), races of common timothy (*P. pratense* L.), and races of alpine timothy (*P. alpinum* L.). The last, however, is itself of no economic value, but hybrid derivatives from common timothy × alpine have yielded some vigorous and fertile types. Several races of diploid timothy ranging in growth-habit from decumbent to extreme erect and from dwarf to large-growing plants have been isolated. The presence of such types within diploid timothy should increase its range of usefulness. Field trials have demonstrated that this timothy is a good bottom grass, and that in fertile pastures the large-growing forms are the most suitable. The less luxuriant forms, however, may have their uses for sowing on poor, dry land, as low dense growth would be an asset where the suppression of weeds and the prevention of surface evaporation from the soil are essential to the establishment of good pasture. Attention is now being given to breeding quicker-maturing and higher-yielding strains of diploid timothy.

Multiplication of Strains.—This year a strain of diploid timothy is being multiplied on a contract basis (4 acres), while another is included in the initial (vegetative) multiplication plots at Corstorphine. Two races of hexaploid timothy

are also being multiplied. One of these, selected for resistance to timothy rust by Mr Bird at Macdonald College, Canada, is in the second-year multiplication plots; the other in the first-year plots shows promise of being a high-yielding hay strain. A strain of cocksfoot which has given satisfactory results in field trials is being multiplied in England under contract (2 acres). In addition to these a strain of late-flowering perennial ryegrass will be seeded for the first time this year.

Our attention has recently been drawn to the difficulties experienced in renewing poor permanent pasture. To plough down the old pasture and start anew is frequently the most economical method. In some instances an endeavour to establish a new pasture on the remains of the old in the absence of an intervening crop has led to failure. Sometimes, however, the cultivation of an intermediate crop—*e.g.*, a cereal or green crop—is impracticable or at least uneconomic. A possible alternative would be the sowing of an *annual* pasture comprising quick-growing races which do not demand a fine tilth for germination and subsequent growth. By adopting such a method the harvesting of a crop would be obviated, and the old turf would receive the necessary consolidation by the tramping of grazing animals before the permanent pasture seeds mixture is sown in the following spring under a nurse crop of a modified seed mixture of annual plants. In view of the above, a preliminary examination of hardy quick-growing annuals of possible pasture value is contemplated this summer, and plots containing various annual varieties of several species have accordingly been laid down.

Mr J. M. S. Lang assisted in carrying out the herbage programme.

D. Root Crops.

(*Swedes and Kales.*)

Assistant in Charge—V. E. M'M. Davey, B.Sc., Ph.D.

The swede-breeding programme remains unaltered, and the work has been continued with the same objectives in view. Some additional studies on kales have been undertaken.

Pedigree Breeding.—About 200 strains of swedes were sown in various groupings. Most of the strains were arranged in

duplicate as small and large observation plots; some, however, were sown in the form of replicated yield trials. Samples of commercial varieties were included as controls, and observations were made on all the plots during the season. Dry-matter analysis and plot weighings were carried out on two small yield trials. In the autumn plants were selected and transplanted into the propagation plots to be seeded there.

Controlled Seeding.—A larger number of mother-plants than usual was handled during 1935, and about 230 strains of swede were harvested. Of these, 95 were pedigree lines derived from plants out of commercial varieties and bred by repeated selection and self-fertilisation, some for seven generations, others for fewer. The other 135 originated from hybridisations, mainly between swede lines, but there were a few between swede × turnip. These strains also were self-fertilised in bag isolation for the generations following the crossing.

Analysis of Hereditary Characters.—Further observations were made on the manner of inheritance of various characters such as yield, dry-matter percentage, shape of bulb, colour of flesh, skin and flower, shape of leaf, splitting, and bolting. In particular some notes were made on the following :—

(1) *Bolting in True Swedes.*—For a third generation some strains were sown out early, on 15th April, so that tendencies to bolt could be observed. Confirmation of previous tests was obtained; certain lines bolted while others did not.

(2) *Flower Colour.*—Small beds of rapes, swedes, and various hybrids were sown in autumn, so that the flower colours could be noted as they appeared in spring. The appearance of lemon flower colour in hybrids of pale yellow (rape) × buff (swede) suggests some interesting interactions of hereditary factors. The rapes have bright lemon or pale yellow flower colour, which may be used to distinguish them from yellow-fleshed swede, which has a buff flower.

(3) *Skin Colour of Swedes.*—In the course of time purple-top, bronze-top, and green-top strains of swedes have been developed into well-defined groups. If one purple-top is crossed with another, it may be expected that all the descendants will have good purple colouring, though differences of intensity may be involved which would need to be fixed by breeding. In the same way, good bronze colours should be obtained from the crossing of bronze-tops, while the crossing of two green-tops should give descendants that are true

breeding for green skin colour. In making crosses between the three groups, however, some practical difficulties are encountered. The cross bronze-top × green-top throws, in the F_2, a series of intensities of bronze coloration grading imperceptibly into the almost untinted skin colour of the green-top. These colours are as attractive as the others, and it would probably not be difficult to breed a fixed colour type, especially the green, which is recessive.

When a purple-top is crossed with either bronze-top or green-top, however, there may be difficulty in recovering good purple skin colours from the descendants. The F_1 offspring is a purple-top of a sort, its neck is distinctly purple, but the colour of the skin may be weak or brown and restricted in area so that a broad band of green encircles the bulb just above ground level. Though not necessarily ugly, this type is unfixed. In the second hybrid generation there is, firstly, a division into two main groups; for 75 per cent have at least the neck purple, while 25 per cent have green or mottled necks, being in fact green-tops or bronze-tops, and incapable, since they are recessives, of throwing purple-top plants in their progenies. An intensely coloured type of bronze-top occasionally occurs, however, which has a strong red pigment on the skin of the bulb. Frequently the neck of this type is highly coloured also, though there is usually green to be found between some of the leaf scars. It is problematic whether this type should be regarded as a purple-top or not, but since the colouring is unattractive it is not likely to be developed on a commercial scale. Of the purple-necked members of the F_2 generation, two-thirds are not fixed, and would throw bronze or green-tops if used for breeding. The other third is true breeding for the purple neck colour, but not necessarily for intensity of skin colour. Many of these have very lightly coloured or almost green bulbs, which gives them a faded or dingy appearance. Consequently many plants which might be worthy of selection for size, shape, and perhaps dry-matter percentage may be disqualified by distinctly unattractive skin colours. It would probably be difficult, and perhaps in some cases impossible, to improve the purple colour in their descendants by selection. Nicely coloured purple-tops may also be present in the F_2, and from such plants lines with good skin colours could probably be bred. The nature of the non-purple-top parent undoubtedly influences

the proportion of good to poor purple-neck types in the F_2 generation. It is likely that green × purple would throw a large proportion of poor colour types, while a dark bronze-top × purple-top might impart good skin colours to all or nearly all the descendants. The explanation appears to be that there are a number of hereditary factors besides the pair governing neck colour, and that several of these must be present for the intensified colour of the purple-top as we know it, whereas their absence does not spoil the appearance of a bronze or green-top. In the reassortments following hybridisation some of the necessary factors may be lacking.

Kales.—In consequence of the recent increase of interest shown in the growing of kales in Scotland, some experiments have been initiated with these crops. It was found that plenty of seed can be obtained from Thousand-headed and Marrow-stem kale under bag isolation. Large plants of the latter, however, may be difficult to rear after transplantation because they are top heavy.

E. Virus Disease Research.

George Cockerham, B.Sc., *Assistant, Craigs House.*
Alan M. M'Bain, B.Sc. (deceased), *Assistant, Ainville Sub-Station.*

During the year three convergent lines of investigation centred upon the major problems of resistance and susceptibility of potato varieties to potato viruses have been followed. The progress of these investigations will be described under the designations classificatory, genetical, and field investigations.

Classificatory Investigations.—The preliminary work upon the behaviour of named varieties and promising seedlings towards infection with individual potato viruses has been extended, and an attempt has been made to classify varieties according to their various reactions towards individual viruses. 155 varieties have been examined with regard to their reactions towards potato viruses X and Y, and arbitrary classes of reaction towards each virus have been set up. The varieties examined have been found to fall into three well-defined classes with regard to their reactions to virus X. The first class, which may be designated the resistant class as the virus though present has no appreciable effect on haulm or yield,

contains 17 varieties which respond to infection either as perfect or as almost perfect symptomless carriers. The second and largest class contains 66 varieties which show mosaic symptoms of varying degrees of severity. The varieties, 30 in number, in the third susceptible class may prove to be the most important from the economic point of view, since, although infection is made evident by the appearance of necrotic effects of a lethal nature, this form of susceptibility may lead to self-elimination of the virus, as the sprouts on the tubers of infected plants and also the plants themselves are killed outright. The reactions of the remaining 42 varieties, belonging to classes one or two, however, have not been definitely established, and they remain therefore unclassified meantime.

The reactions of the above varieties to the Y virus have proved to be more complex than the reactions to the X virus. Tentatively, 12 classes of reaction have been distinguished. These classes may be brought together under two groups, of which the first group of 25 varieties includes those in which disease symptoms are not pronounced and the plant vigour is not affected to a large degree. The second group of 124 varieties includes all those varieties which show severe symptoms of infection and definite reduction in vigour. It was not possible to determine the reaction of 6 varieties owing to the presence within them of virus complexes such as A + X and X + Y.

This work has been extended to cover a further selection of varieties, and also in relation to the reactions of potato varieties towards the A virus and the A + X complex. The results of this extended investigation are not yet complete.

Genetical Investigations.—Data of a genetical nature are being accumulated from the observations made upon seedling progenies in the field trials. Even at this early stage of investigation it is quite evident that resistance and susceptibility to virus infection, as judged by symptom expression, are hereditary features. The data are not yet sufficient, however, to throw light upon the mode of inheritance involved.

The inheritance of reaction to virus X has been studied in greater detail by stem grafting in seven progenies comprising 324 plants. This investigation has indicated that reaction is an inherited character probably dependent upon two or more genetical factors. This work is being extended with regard to virus X and also to include virus Y.

Field Investigations.—Two field trials, in which all the

plants under test had equal chances of infection, were carried out for the purpose of testing selected named varieties and seedlings with respect to their resistance or susceptibility to infection with virus diseases under natural conditions. The two trials, one of which was concerned with the leaf-roll virus and the other with the Y potato virus, were well isolated from each other and from external sources of infection. The behaviour of the plants in these trials was taken into consideration when selecting parents for further breeding.

151 named varieties and approximately 1500 seedlings, the latter representative of 12 different families derived by self-fertilisation and hybridisation of selected parents, formed the material for study in the leaf-roll trial. The seedling progenies included those seedlings which had survived a similar test in 1934. A large proportion of the latter were found, in 1935, to have contracted leaf-roll in 1934, although definite symptoms of infection were not produced in that year. This observation is of interest in connection with the data which have been collected upon the occurrence and spread of aphides, data to which further reference will be made. Amongst the seedlings which had been placed in this field trial for the first time, infection, as judged by the appearance of primary symptoms, was not observable until the end of September, and definite results are not yet available as senescence and frost precluded further attempts at diagnosis of symptoms after this time.

In the corresponding investigations relative to the Y virus 151 named varieties and 750 seedlings in nine progenies were included in the trial, and results obtained were more definite than in the case of the leaf-roll trial. A slight passage of infection from the diseased sources was observed early in the season and at intervals throughout the summer. The bulk of infection, however, took place at the beginning of September. The spread of infection, which ultimately covered at least 58 per cent of the seedlings in the trial, has again been correlated with the data relative to the aphis population of the plots.

Aphides.—At intervals throughout the whole season observations were made upon the aphis population within the bounds of the leaf-roll and virus Y plots. The data, which are of a semi-quantitative nature, reveal slight differences between the two plots, probably in respect of their slightly different environments. Both showed similarities, however, in the

general distribution of aphides, and these data corroborate observations made elsewhere in eastern and north-eastern Scotland during the year under review and in previous years. During the early part of the season *Myzus persicæ* was present in very small numbers, on the average less than one aphis per plant, and did not increase appreciably until mid-August. The aphis predominating, though never present in large numbers during the early summer, was *Macrosiphum gei*, which appeared coincident with flowering in mid-July and which colonised chiefly upon the flowers. In mid-August *Myzus persicæ* began to increase rapidly and also to appear in the alate migratory form. The maximum infestation was observed at the end of August, and it is interesting to record that it was shortly after this data that a large and rapid spread of infection was observed with regard to both leaf-roll and the Y virus. As a result of this late infestation and passage of infection, it is to be expected that symptom expression will be delayed in many cases until the year following infection, such as has been recorded in the case of second-year seedlings in the leaf-roll trial.

Breeding.—The practical aspect of the work on classification of potato varieties with regard to their behaviour towards individual viruses, when considered together with the results of the greenhouse and field analyses of seedling progenies, has become quite clear. Those varieties which upon artificial infection have been classed as susceptibles have produced offspring which are also susceptible, whereas the parents in the more resistant classes appear to have transmitted resistant qualities to their offspring. The varieties which fall into the resistant classes are, however, for the most part varieties which possess undesirable features. Particularly is this true of varieties showing resistance to leaf-roll. Consequently the use of resistant parents in purely commercial breeding operations has been neglected, and a very large proportion of the commonly grown varieties of to-day fall into the susceptible groups. It is quite evident, therefore, that breeding on empirical lines from the varieties in commercial use, or from their seedlings, will prove unsatisfactory as a method for producing resistant varieties. Breeding has been pursued during the year, therefore, along the following lines :—

(1) Varieties showing resistance to one or more viruses, or to natural infection under field conditions, have been self-

fertilised or hybridised with the object of providing seed for extended investigations into the mode of inheritance of resistant qualities. Hybridisations in this group include a proportion of crosses made for the purpose of combining resistance with those qualities which are at present judged to be essential in commercial varieties.

(2) Varieties showing extreme degrees of susceptibility to individual viruses have been self-fertilised and intercrossed, and hybridisations between susceptible and resistant varieties have also been made with the object of pursuing genetical studies.

(3) Continued self-fertilisation of inbred seedlings from resistant parents have been made.

In every case the choice of parents has been governed chiefly by the results of the classificatory work previously referred to.

Ainville Sub-Station.—The sub-station at Ainville has been used mainly for maintaining and supplying healthy material for the virus work in progress at Craigs House. All newly imported material has been first grown at Ainville and examined by direct observation and by inter-varietal grafts for the presence of viruses. In the past year 146 new stocks have been thus examined. 75 of these were found to be infected with one or more of the viruses X, Y, and A, whilst the remaining 71 were apparently free from these viruses.

From seed secured in 1934, 1100 seedlings in 17 progenies have been raised for inclusion in the susceptibility trials at Craigs House in 1936.

The whole of the breeding work has been undertaken at this station, and seed has been supplied from 40 hybridisations and 12 self-fertilisations. A proportion of this seed has been sown to provide material for study in 1936 and 1937.

Attention has also been devoted to the study of abnormal and semi-abnormal plants. The material used in this investigation was raised entirely from tubers of second and third-year abnormal seedlings, and useful descriptive data have been obtained.

II. Visits by Members of the Staff during the Year ended 31st March 1936.

J. W. Gregor, Ph.D., F.L.S. :—

The Plant Experimental Station, Samsstodum, Iceland.

William Black, B.Sc., Ph.D. :—
Sixth International Botanical Congress, Amsterdam.

George Cockerham, B.Sc. :—
Potato Testing Station, Ormskirk, Lancs.
Sixth International Botanical Congress, Amsterdam.

George Cockerham and the late Alan M. M'Bain, B.Sc. :—
University College of North Wales, Bangor. (Annual Conference of Virus Diseases of Plants Committee and Workers.)

III. Demonstrations.

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

IV. Acknowledgments.

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

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