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SCOTTISH PLANT BREEDING STATION
PENTLANDFIELD
ROSLIN
MIDLOTHIAN.

By SSRPB Res. Dr. J

Annual Report [1938]
Annual Report [1939]
Annual Report [1940]
Abridged 20th Report [1941]
Abridged 21st Report [1942]
Abridged 22nd Report [1943]
Abridged 23rd Report [1944]

1938

REPORT

BY

DIRECTOR OF RESEARCH.

I. Research Programme.

Breeding experiments are in progress with Grain Crops, Potatoes, Pasture Plants, Swedes and Kales, and a review of the year's work at the Scottish Plant-Breeding Station is given in these pages.

The provision of an assistant at the Plant-Breeding Station to undertake the preparation of material for examination of certain cell contents of plants (*i.e.*, chromosomes) has been advantageous, and full use of this service has been made by the members of the staff. A large amount of material has been examined, and the information obtained has been helpful in differentiating certain types which could not be distinguished superficially. The identification of plants having different chromosome complements is of much importance to plant-breeders, as the chromosomes play an important rôle in the reproductive and the hereditary mechanism of plants. It is now possible by various means artificially to duplicate the number of chromosomes in some plants, and the discovery in 1937 by Blakeslee and Avery that the substance known as colchicine induces chromosome doubling, is of great interest, as it opens up new possibilities for the plant breeder. Attempts are being made at the Station to induce the duplication of chromosome sets in various species of agricultural plants to see whether any results of practical value may be obtained.

Grain Crops.

William Robb, *Director of Research*,
and
S. G. Stephens, M.A.

Oats.

The main problems of the oat breeding programme are the production of :—

(1) improved varieties adapted to fertile soils and highly resistant to lodging ;
(2) early-ripening varieties adapted to soils of medium and low fertility in late districts ;
(3) a variety of commercial value possessing thin-skinned, well-filled grain which will not readily sprout in the stook at harvest ;
(4) a hardy and productive variety of oat with huskless grain, which is known to be a nutritious poultry food.

Investigations are also in progress to obtain information regarding various factors bearing on the yielding capacity of different varieties, and also on the heredity of certain botanical characters.

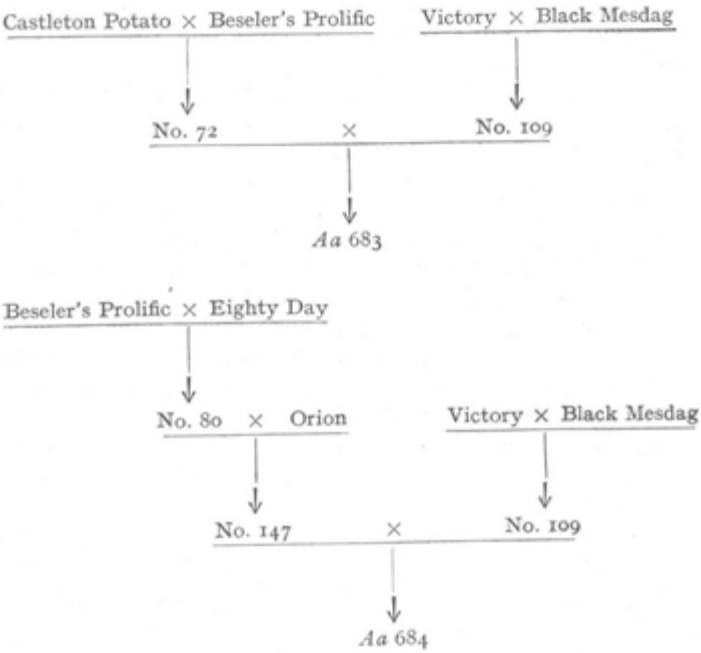
As mentioned in last year's report, the short-strawed oat known as Semi-Dwarf, which is highly resistant to lodging, has been used as a parent with Elder and Early Miller, and second generation progenies of these crosses consisting of about 470 plants were grown in 1937 for observation and selection. There was a wide range of types, including some that showed a combination of the short-straw character of Semi-Dwarf and the higher productive capacity and better type of grain possessed by Elder and Early Miller. About 3000 second generation plants were also grown from other crosses, and many promising types occurred in the undernoted combinations—

Elder × Marvellous, Potato × Marvellous, Early Miller × Elder, Early Miller × (Castleton Potato × Yielder).

It would appear that from an oatmeal miller's point of view a grain sample containing an appreciable proportion of small

though plump seeds is unsuited for milling purposes. Oat grain is frequently marketed by farmers direct from the threshing machine and it is not graded to separate all the small grains from the firsts. For a good milling oat it is therefore desirable to aim at raising a highly productive variety which has thin-skinned, well-filled grain of uniform size.

Among the early-ripening hybrids selected for trial mainly on upland soils two promising varieties—viz., *Aa* 683 and *Aa* 684 have been undergoing tests for a few years. Both of these are selections from crosses between unnamed varieties raised at the Station and they have been included in the Registration Trials conducted by the Department of Agriculture for Scotland in 1936 and in 1937. They are being included in these trials again in 1938. The parentage of these two varieties is shown below :—



Several white-grained selections from F_5 generation progenies of Elder × Orion, which also ripen very early and have short straw, seem fixed, and they are being increased in

quantity. They will be included in comparative trials as soon as possible.

Four promising F_6 generation hybrid selections of huskless oats from Liberty × Argentine appeared to be fixed, and three of them have been retained for comparison in small preliminary trial-plots in 1938. In the small initial multiplication plots the grain of these four selections germinated evenly. The straw showed no tendency to lodge; the 'heads' or panicles were well furnished, and further trials will be made to ascertain grain-yielding capacity.

Unlike the grains of most cultivated oats, the grain of the Wild Oat (*Avena fatua*) will not germinate for a time after it is 'ripe'; it requires a resting or 'after ripening' period of several weeks before sprouting can take place. It has been found possible to transfer this character of 'delayed germination' to the cultivated oat by crossing. Among the progeny of a cross between *A. fatua* and Elder have been found segregates whose grains resemble those of the cultivated parent in external characters, but which will not germinate until about one month after harvest. It is hoped to fix this character by further selection.

Twenty-four fixed hybrid selections and six standard named varieties were included in a replicated field trial-plot at the Station, and comparisons of these were made. The relative grain-yielding capacity of the early-ripening varieties is often difficult to ascertain because of the destruction of part of the grain by birds, but judging by appearances some of the very early-ripening selections may prove useful in late districts where early ripening is of first importance. A few hybrids selected from Victory × Argentine, from Star × Marvellous, and from a cross between two unnamed varieties were among the most outstanding as regards yield of grain and strength of straw. While the grain yields from these were higher than those obtained from Victory and Star they did not reach statistical significance. It may be mentioned, however, that through irregularities in the plots the standard error for grain yield was rather high, thus making it more difficult to differentiate among the different grain yields. These selections have well-filled grain of medium size, and they showed no tendency to lodge. They will be included in various trials in different localities in the near future.

Pure stocks of the Society's Elder, Bell, and Early Miller oats were grown in 1937, and there was a good demand for seed of Bell and Early Miller. Bell has been giving satisfactory results in some areas in the North of Scotland. Early Miller has also been favourably reported upon. In the report of the Oat Trials carried out at the Cumberland and Westmorland Farm School in 1937, it is stated :—

> "The outstanding oat this year was Early Miller, a comparatively new Scottish oat (Potato × Record). . . . Throughout the season it was an outstanding plot and, besides giving the highest yield, was ripe three days before any other variety."

Barley.

Second generation hybrids derived from two crosses (Spratt Archer × Kenia, and Plumage Archer × Kenia) are being grown on a fairly large scale, and they will furnish material for selection. Kenia is one of the most promising continental barleys of recent years, being early ripening, highly resistant to lodging, and having one of the highest 'extract' values of malting barleys. Its grain quality is fairly good, but it has a higher nitrogen content than either Spratt-Archer or Plumage-Archer. A combination of its qualities with those of the two latter varieties would therefore seem desirable.

A series of crosses between an awnless six-rowed barley and various two-rowed malting barleys has given rise to a wide range of two-rowed forms. Among these, the awnless types, the deciduous awned types, and the very short and stiff-strawed types are of especial interest.

Multiplication of Scotch Common barley selections was continued, and several of them will be tested in the North of Scotland in 1938.

Wheat.

One fixed hybrid selection from a cross Squarehead's Master × White Spelt, which on a small scale has shown promise of possessing a high tillering capacity and of being very winter hardy, is being multiplied.

The remainder of the work has been concerned with spring wheats. Spring wheats on the market at the present time suffer from several defects—*e.g.*, lateness in ripening, weak straw, susceptibility to Loose Smut (*Ustilago tritici*). A collection has been made of several foreign varieties which in their own countries have proved to be early ripening and highly resistant to or immune from Loose Smut. A series of crosses has been made between Japhet (= Red Marvel) and the most promising of these varieties.

Beans.

Crosses are being made between bean varieties cultivated in this country (Kilbride and Dwarf Long Pod) and certain Russian varieties, which show distinctive differences from the former.

The progenies of a few single plant selections of field beans were multiplied, and observations were made on several varieties of soya beans which were grown on a small scale.

Potatoes.

William Black, B.Sc., Ph.D. (Ainville Sub-Station).

The problem of breeding new varieties of potato highly resistant to blight (*Phytophthora infestans*) has been further investigated with encouraging results. About 900 seedlings, drawn from a number of parent sources, were tested under controlled conditions using a local strain of the fungus, and 59 per cent of them proved to be resistant.

The mode of inheritance of resistance to blight appears to be complex, but resistance is dominant to susceptibility. All the first generation (F_1) seedlings derived from *S. demissum* (resistant) crossed with The Alness (susceptible) and with Shamrock (susceptible) were found to be resistant. In F_2 and back-cross generations various ratios (resistant to susceptible) were obtained, but in each case the resistant plants were numerically greater. In these experiments resistant seedlings were, of course, always selected as parents. Four second generation seedlings, when back-crossed to The Alness, gave

FIG. 1.
A heavy crop of Early Miller oats being cut at East Craigs, Corstorphine, 1937.

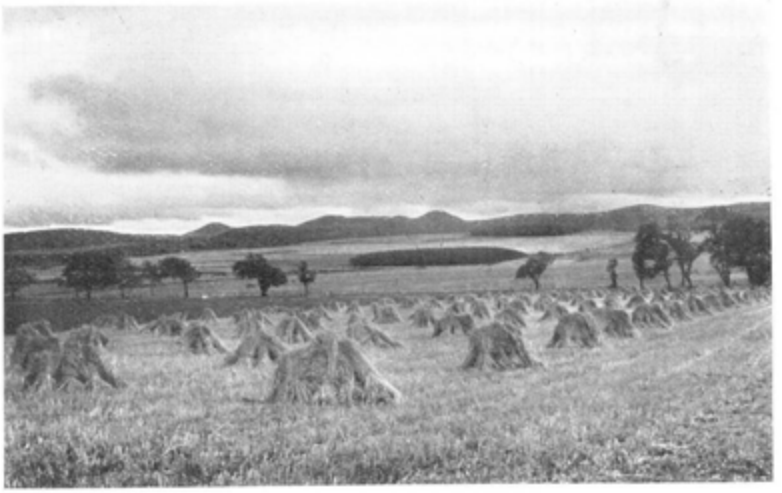


FIG. 2.
Trial-plot of early-ripening oat, No. *Aa* 683, at Ainville, Kirknewton, 1937. Elevation of field about 900 feet above sea level.

FIG. 3.
Marrow-stem Kale, Line M 11. Stem stout; leaves curved, large; margins somewhat curled.

FIG. 4.
Marrow-stem Kale, Line M 6. Stem long; leaves rigid; margins somewhat curled.

FIG. 5.
Thousand-headed Kale, Line T 5. Leaves drooping, broad; margins somewhat curled.

FIG. 6.
Thousand-headed Kale, Line T 1. Leaves erect, oval; margins plain.

respectively 76.3 per cent, 63.5 per cent, 61.8 per cent, and 54.3 per cent resistant offspring.

The Society's disease-resistant seedling, 967*c* (38), which has wild species in its ancestry five generations back, gave 44.2 per cent resistant offspring when crossed with Katahdin. From the study of the botanical characters of resistant seedlings it becomes apparent that resistance to blight is transmitted independently, or at least is not linked with any 'wild' character which would be inacceptable in a cultivated variety.

The new seedlings raised in continuing the investigations involving the use of wild tuber-bearing solanums numbered over 2000. Most of them were descendants of the hexaploid species *S. demissum*, but other wild species used as parents were *S. andigenum*, *S. Rybinii*, and *S. tuberosum*. In breeding with *S. demissum* repeated back-crossing with selection of the best of the resistant forms is the method which is being followed.

The intercrossing of distinct species is frequently followed by male sterility in the hybrids, particularly in cases where different chromosome complements have been combined. The hybrids of true wild species invariably show the 'wild' characters of the parents. It is only when a variety of a cultivated species is crossed with a wild species that a definite improvement from an economic point of view is effected on the wild type, and doubtless the utilisation of British varieties offers the most effective means of progressing in the desired direction. In a few cases triple hybridisation has been carried out with promising results.

Two-tuber samples of sixty varieties of South American potatoes, obtained by arrangement with the Imperial Bureau of Plant Genetics, Cambridge, were planted in pots in an insect-proof greenhouse early in January this year. The tubers were collected by the Percy Sladen expedition to Lake Titicaca, Peru, in 1937, and the varieties are being multiplied for experimental purposes.

About 1150 new seedlings were raised in connection with the investigations relating to the effect of inbreeding and subsequent crossing of inbred varieties. Most of the seedlings were from repeatedly inbred generations, but a few progenies were secured from crosses between inbred lines. It was noted that, under similar conditions of growth, the progenies of the inter-crossed lines showed increased vigour and gave higher

yields of tubers as compared with the self-fertilised lines as a whole. At the same time, many of the selections from inbred lines raised in previous years produced vigorous plants and gave yields comparable with those of commercial varieties.

About 1450 seedlings were raised to provide material for selection of economic types, and these were obtained from crosses between commercial varieties or their derivatives. In this group are progenies derived from the blight-resistant seedling *967c* (38). It was crossed with Cardinal, which gives a lethal top necrotic reaction to viruses A and X; Katahdin, which is claimed to be resistant to mosaic; and Shamrock, which possesses some degree of resistance to the Leaf-Roll virus. A number of promising blight-resistant selections was obtained from these progenies, and they will be compared with standard cultivated varieties in 1938. Other parent combinations which produced high proportions of promising seedlings were Catriona × Arran Signet, Doon Early × The Alness, Gladstone × 70 (13), Doon Star × Katahdin. Many selections with coloured or partly coloured tubers arose in the progenies bred from Catriona, Gladstone, and Kerr's Pink.

The second-year seedlings, rather more numerous than usual, contained many useful types giving good crops of finely shaped tubers. Several promising early-maturing varieties resulted from the crossing of two early-maturing seedlings bred from Kerr's Pink. This group also contained some attractive blight-resistant selections derived from *967c* (38) crossed with The Alness and with Pepo.

A number of the more advanced seedlings were included in the trials conducted by the Department of Agriculture for Scotland at East Craigs and by the Ministry of Agriculture and Fisheries at Ormskirk. The report from Ormskirk states: "The small lots you sent are some of the most attractive seedlings I have had here, and it is refreshing to see so many kidney-shaped tubers, which is the shape we want in England."

The Department of Agriculture for Scotland trials at East Craigs contained eight of the Society's seedlings, and three of them—viz., 322 (80), *384a* (14), and *451a* (20) were recommended for further trial in 1938. A few notes referring to them are given in Table I.

A further group of five new varieties—viz., 322 (37), *373a* (41), 447 (32), 449 (83), and 450 (100) were selected for inclusion in

the 1938 trials. In addition, seedling 318 (38), previously recommended for further trial, but withheld in 1937 on account of scarcity of seed tubers, was included in the trials for 1938. Details of these varieties are given in the lower portion of Table I.

TABLE I.

Reference Number.	Parentage.	Maturity.	Tuber.		
			Shape.	Colour.	Cooking Quality.
318(38)	May Queen × 121(2)	1st-Early	Oval	White	Good
322(80)	966*f*(1) × Herald	Maincrop	Oval	White	Very Good
384*a*(14)	Kerr's Pink × The Alness	Maincrop	Kidney	White	Very Good
451*a*(20)	Epicure × Pepo	Early-Maincrop	Kidney	White tinged pink	Very Good
322(37)	966*f*(1) × Herald	Maincrop	Kidney	White	Very Good
373*a*(41)	British Queen × The Alness	1st-Early	Oval	White	Good
447(32)	Catriona × Herald	Early-Maincrop	Kidney	White	Very Good
449(83)	Catriona × 188*a*(91)	2nd-Early	Oval	White purple eyes	Very Good
450(100)	Epicure × Herald	Early-Maincrop	Long-Kidney	White tinged Pink	Very Good

PASTURE PLANTS.

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

Perennial Ryegrass.—Under the environmental conditions prevailing at the Plant-Breeding Station all the races of this

species collected from natural or semi-natural Scottish habitats have proved to be late-flowering and slow to start growth in the spring. Such races undoubtedly have their uses, but at the same time it is believed that a persistent and early variety of perennial ryegrass would be most valuable. In most Scottish collections there are, however, a few individuals which are relatively early, and these have been chosen for breeding work. It has by this means been possible to breed races which on the average begin growth slightly earlier in the spring than do their parent populations. Preliminary trials of varieties from more southerly districts indicate that some semi-natural populations are to be found which are earlier under northern conditions than any yet examined from Scotland. Mr F. R. Horne of Seale Hayne Agricultural College has very kindly supplied seed samples of perennial ryegrass collected from various habitats in Devon and Cornwall, and these have been sown this year.

Cocksfoot.—Harsh foliage and stems is a common feature of indigenous populations of cocksfoot. For the last few years numerous habitat collections have been examined and the best types isolated. But with few exceptions these are characterised by rough stems and leaves. Crosses are now being made with a view to obtaining smooth-stemmed strains which will retain the good characteristics of the best indigenous types.

Timothy.—Pasture races of diploid timothy, and both pasture and hay races of hexaploid timothy, are being studied. Attempts are being made to increase further the size of diploid timothy.

Improvement of Poor Pasture. — The *Agrostis*-dominated pastures are, of all the poor permanent grassland types, the most amenable to reconditioning, and it is probable that the one and a half million acres in Scotland classified as permanent grass falls within this category.

Ploughing and the encouragement of an ample growth of wild white clover are the basis of poor pasture improvement. But *Agrostis* pastures in upland districts are not as a rule capable of being immediately converted into highly productive ryegrass-wild white clover swards without previously killing the bent-grasses and raising the level of soil fertility very considerably. On many upland farms considerations of finance,

climate, and labour make it impracticable to resort to a period of rotational cropping between the ploughing up of poor pastures and resowing to grass. The practical problem is therefore one of finding methods whereby pasture can be re-established without an intervening period of arable cropping. The possible advantages of utilising specialised varieties of pasture plants for this work brings the question of grassland renovation directly within the scope of the Society's herbage programme. The use of specialised varieties not only of perennial grass species but also of their nurse crops has therefore received attention at the Plant-Breeding Station. For example, wild white clover when growing on poor land may seriously suffer in the spring from the effects of shading by plants of earlier development. It is necessary, therefore, to ascertain whether, while the conditions of soil fertility are still low, it would not be more advisable to sow only those grasses which have a growth rhythm coincident with that of wild white clover. Moreover, it is also necessary to determine whether it would not be advisable in the initial stages of renovation to refrain from growing strains of species which require generous manurial treatment until such time as conditions have been made more favourable by the use of varieties more tolerant of poor conditions.

These plant-breeding aspects of the pasture reconditioning problem have received special attention at the Plant-Breeding Station, and sufficient seed of a number of contrasting varieties within each of the palatable species perennial ryegrass, cocksfoot, and timothy has now been secured to allow of field tests of their usefulness being made. A trial area at an elevation of 900 feet above sea level, and typical of much of the low-fertility grasslands of Scotland, has been acquired at the Society's Sub-Station at Ainville. Two acres of this area have been sown in such a way that it will be possible to obtain data relative to (*a*) the behaviour under grazing conditions of different varieties of the same species growing singly and in mixtures, and of combinations of specialised strains of different species; and (*b*) the influence of different grass varieties on the growth of wild white clover.

Multiplication of Seed for Sale.

Timothy (*Cb* 191).—Four and a half acres of this pasture

variety of diploid timothy were again seeded last year and a yield of 12 cwt. of dressed seed was obtained.

Cocksfoot (*Cc* 180).—Seven acres of this variety yielded 12 cwt. of seed. The same acreage has been retained for seed production this season, and an additional five acres of cocksfoot has been sown in Essex by arrangement with the Essex Seed Growers' Association.

All last year's seed of both these varieties was disposed of this spring.

The undernoted new varieties are being multiplied for seed for trials :—

Timothy (*Cb* 213). — A rust-resistant variety which has withstood severe defoliation by cutting. Twenty pounds of seed has been saved and used for laying down grazing trials, and also an acre multiplication plot.

Timothy (*Cb* 224).—A vigorous erect variety of hexaploid timothy.

Perennial Ryegrass (*Ca* 434). — A late-flowering pasture variety bred from a population of Scottish origin.

Experimental Taxonomy.

The study of racial differentiation in wild populations of sea-plantain has been continued, and a further instalment of the results has been published in the 'New Phytologist,' Vol. 37, No. 1, 1938. This paper records that while for such characters as plant size and growth-habit wild populations differ in response to local environment; in respect of other characters which exhibit no ecological sequence such populations differ locally as a result of chance circumstances.

Root Crops.

(Swedes and Kales.)

V. M'M. Davey, B.Sc., Ph.D.
J. M. S. Lang, B.S.A.

The investigations into methods of breeding swedes were continued; and those of kale breeding yielded some preliminary information.

Both kales and swedes are normally propagated by selecting and seeding plants in mass. Consequently there is often considerable variability in the hereditary constitution within a variety, which might be reduced by some more strictly

controlled method of breeding. There are, however, two difficulties which generally prevent the use of inbreeding, and especially of self-fertilisation, in crops of this nature. One is self-sterility, which may be so pronounced as to preclude the formation of seed altogether; while the other is lack of vigour and reduced yield which may follow inbreeding.

The swede is somewhat exceptional among root crops in being self-fertile, nor does inbreeding appear to harm it. Plenty of seed is obtained when the inflorescences of a swede plant are enclosed in a pollen-proof bag. This method has been used to breed 'pedigree lines,' some of which have now passed through eight generations of self-fertilisation. Yield trials on some of these lines have shown that though about a third are inferior to the commercial varieties from which they were derived, a third are more or less equal in value and a third somewhat superior. Consequently, inbreeding need not be detrimental to the health and vigour of a swede strain.

Similar investigations have been commenced recently with marrow-stem and thousand-headed kales. About twenty selected plants of each form were seeded in pollen-proof bags, and it was found that the degree of self-fertility varied considerably. Only one marrow-stem and four thousand-headed kale plants could be classed as self-fertile, some were almost completely self-sterile, and the rest showed partial fertilities. Thus the production of pedigree lines would be difficult, and the more self-fertile types would tend to be favoured.

In 1937, the progenies were sown out in plots with commercial varieties as controls. In July it was very apparent that none of these once-selfed strains possessed the size and vigour of the commercial varieties. Towards September, however, they improved, and the difference was not so noticeable during the winter. This relative lack of vigour following inbreeding precludes the use of 'pedigree lines' derived from single plants to form strains. If improvement is possible it may, however, take the form of blending together similar but unrelated lines. The appearance of these kale progenies was most interesting. Various habits of shaw, and shapes of leaf, were exhibited, especially in the thousand-headed kale. Each progeny was distinctive, though by no means true-breeding. The plants differed in detail, but resembled each other more closely than they did plants of other progenies. Some of the progeny strains seemed to be of economically suitable types;

provided that full vigour could be restored by out-breeding. The next phase of this work is the crossing of similar unrelated strains with a view to finding the best combinations, and this has been begun on the plants selected from the 1937 trials. The marrow-stem kales showed less diversity in leaf types, though there appeared to be differences in the number of leaves borne. Their stems were of different lengths, and a short, very stout type appeared. The symmetry of the stem was in some strains marred by coarse projections below the leaf scars, while in others the stems were smooth.

The first line of thousand-headed kale to be selected, 'T1,' was of the self-fertile type. A number of plants of the first generation were bred in 1937, and they also proved to be self-fertile. The habit of this strain was thought to be of interest economically, and attempts have been made to find unrelated plants of similar appearance with which to cross-breed it.

Swede Pedigree Breeding.—In consequence of the damage caused to breeding plants during the severe winter of 1935-36, only eighty samples of swede seed from self-fertilised plants were available in 1937. The trials were filled up by the inclusion of old seed to perpetuate lost lines, by commercial varieties, and by a large assortment of new crosses. The crops, though thin, were of a fair size, and in the autumn plants were selected and transplanted into the propagation plots to be seeded.

Yield Trials.—A yield trial was carried out on some mass-multiplied lines, the plots being tested for yield, dry-matter, soluble solids, and sugar. A second trial was made on an area sown out with one variety. The area was marked out as plots and tested to find the effect of various plant numbers on the average bulb weight and dry matter percentage. Single plots of various strains were also tested.

Controlled Seeding.—In order to replenish stocks of seed which had been depleted in the preceding years, the number of breeding plants was greatly increased. About 300 samples of swede seed were obtained in self-fertilisation, and thirty by hand-crossing. A few kales and turnips were also bred. The season was very favourable, and large quantities of seed were obtained from most plants.

Diseases.—The selected strains grown in the finger-and-toe

infected plot were almost exterminated by the virulence of the disease. In one area, where there was better drainage, however, the plants were not so badly damaged, and of these the least infected were kept for breeding.

A method of testing swedes for resistance to finger-and-toe disease in the seedling stage has been devised by J. G. Gibbs in New Zealand, and preliminary experiments were commenced to apply the method to the line-breeding work at Corstorphine. It is thought that if larger numbers of plants can be examined, as in this seedling test, there may be more chance of making progress with this part of the work.

Virus Disease Research.

Potatoes.

George Cockerham, B.Sc., Ph.D.
Charles A. Lyall, B.Sc.

The main outline of investigation continues to be similar to that given in previous reports—viz.: the classification of potato varieties according to their reaction to the viruses A, X, and Y; genetical studies into the inheritance of reaction to virus X and virus Y; studies into the inheritance of resistance to virus Y and the leaf-roll virus; and studies of the seasonal variations in aphis populations.

The reactions of named varieties after artificial infection with virus A have been studied in 169 varieties of which 88 have shown necrotic reactions. Two types of foliage necrosis have been identified, and the possibility of using necrosis of the tubers as a diagnostic character has been examined.

Twenty-four additional varieties have been infected with virus X and their reactions classified. The inheritance of reaction to this virus has been followed in a study, through artificial infection, of 1237 seedlings of which 443 were of hybrid parentage, 135 were of selfed parentage, and 659 were raised from seed secured by self-fertilisation of selected F 1 plants. Further evidence has been obtained of the existence of a dominant factor controlling a necrotic reaction to virus X which is ultimately lethal to the affected plant. A high value may be attached to the positive identification of this character,

as its use in breeding offers a very probable method of control of the diseases caused by virus X and its various complexes with other viruses. The economic significance in practical potato culture of varieties bearing the necrotic factor has, indeed, been proved of outstanding value as a result of an extended examination of the field data collected in Scotland by the inspectors of growing crops of potatoes. This information was made accessible by the courtesy of the Department of Agriculture for Scotland. Analysis of the data given for each individual inspected crop in 1937 shows clearly that anecrotic varieties, and in particular those varieties known to be commonly infected with or to 'carry' virus A, are rarely to be found in a mosaic-free condition. The proportion of stocks of these varieties with more than 3 per cent of severe forms of mosaic is, moreover, relatively large. Varieties necrotic to virus A, on the other hand, although for the most part infected to a greater or smaller degree with simple mosaic, are almost entirely free from severe mosaic. A third and outstanding group of varieties, namely, those necrotic to virus X, are almost entirely free from both simple and severe forms of mosaic. It is clear then that the amount of mosaic disease in Scotland is chiefly a function of the varietal reactions to viruses A and X. This is strengthened by the further evidence that the Y virus is relatively rare and, indeed, is localised mainly in the South-Western districts. It is submitted, therefore, that a policy of potato breeding directed towards the raising of varieties necrotic to virus A and virus X would be justified as a method of improving the health of potato stocks in Scotland. The established fact that the necrotic reaction to virus X is a dominant character inherited in simple Mendelian fashion assumes considerable importance in this relation and affords a basis upon which to establish a programme of breeding.

The mode of inheritance underlying the transmission of characters determining intensity of mosaic reaction is still obscure, although the data obtained in the current year show quite clearly that the inheritance is transgressive.

Controlled infection with the Y virus has been made upon 20 additional varieties and 209 seedlings in three related progenies. The greater proportion of the inheritance studies with this virus has been carried out under conditions of natural infection in field trials. In the current year 1057

seedlings were placed in the trials. Of these 125 seedlings were in the third year of trial, 132 in the second year, and 800 were placed in the trials for the first time. Over the two completed years of trial—viz., 1935 and 1936, 634 seedlings of a total of 853 have been eliminated as susceptible to virus infection. Sixty-five per cent of the total number of seedlings were found to be susceptible after one year under conditions of infection, and a further 11.5 per cent after two years.

The leaf-roll trials contained 2447 seedlings, of which 481 were in the third year of trial, 644 in the second year, and 1322 in the first year. Over the two completed years 601 seedlings of a total of 1516 have been eliminated as susceptible to virus infection. Elimination by susceptibility occurred to the extent of 28.1 per cent in the first year and 30.5 per cent in the second year.

It is evident from the percentage of diseased plants after each year of trial that a proportion of the seedlings escape infection purely by chance and not through any quality of resistance. In order to assess resistant qualities it seems necessary, therefore, that seedlings should remain in the Y virus trials over a minimum period of three years, and in the leaf-roll trials over a period of at least four years.

Of the seedlings which have received infection, small and varying proportions in the various progenies have shown a partial resistance to the effects of the pathogen, whether virus Y or leaf-roll, by their relative strength of haulm and yield of tubers. The most outstanding of these seedlings have been preserved for future breeding activities.

The aphis surveys during the year revealed that *Myzus persicae* appeared on the plants much earlier than in the preceding two years. The rate of increase and the maximum number of aphides were quite similar in all three years, however, and in consequence the major difference in seasonal variation is to be found in the times at which maximum values were reached. In the year under review maximum values were obtained in all counts at the end of July, as compared with the end of August and the beginning of September in 1935 and 1936 respectively. The early maximum in 1937 was attributed to the absence of cold easterly winds and concomitant sea mists during the months of May and June.

The raising of seedlings for future trials and the breeding

of new material for the virus investigations has been the chief work undertaken at Ainville Sub-Station. Approximately 1200 seedlings were raised during the year, and breeding has yielded seed from 15 cross-fertilisations and 48 self-fertilisations.

II. Publications and Lectures by Staff, for the Year ended 31st March 1938. Publications (P) and Lectures (L).

Director of Research :—

"Huskless Oats." 'The Scottish Journal of Agriculture,' Vol. 20, No. 2, pp. 161-165, 1937. (P)

"The Breeding of Cereal Plants." Glasgow University Botanical Society, 23rd November 1937. (L)

J. W. Gregor, Ph.D., F.L.S. :—

"Experimental Taxonomy." Genetical Society, 26th June 1937. (L)

"Genetics in relation to Systematics." British Association, 1937. (L)

"Experimental Taxonomy. II. Initial population differentiation in *Plantago maritima* L. of Britain." 'New Phytol.,' Vol. 37, No. 1, 1938. (P)

George Cockerham, B.Sc., Ph.D. :—

"Potato Flowers and Dissemination of Potato Viruses." 'Nature,' 140, 1937. (P)

Visits.

Director of Research :—

Rothamsted Experimental Station, Harpenden, Herts.
Craibstone Experimental Farm, Aberdeen.

George Cockerham, B.Sc., Ph.D., and Charles A. Lyall, B.Sc. :—

Rothamsted Experimental Station, Harpenden, Herts. (Annual Conference of Virus Diseases of Plants Committee and Workers.)

III. Demonstrations.

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

On the occasion of the visit of a number of Grassland Congress delegates, a special herbage exhibit was staged, and the herbage experiments described in detail.

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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Department of Agriculture for Scotland, per T. Anderson, T. P. M'Intosh, and R. J. Scott.
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Wiggans, Professor R. G., Cornell University, U.S.A.
Wormald, H., East Malling Research Station, Kent.

Thanks are also due to members of the staffs of the three Scottish Agricultural Colleges who arranged and supervised the trials of certain of the Society's new varieties of oats and grasses.

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