

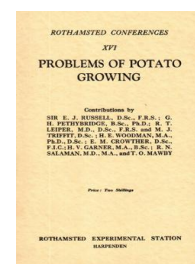
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Problems of Potato Growing

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Potato Diseases

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POTATO DISEASES

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THERE are so many specific diseases of the potato plant, due to parasitic fungi and bacteria as well as to viruses—to say nothing of depredations due to insects and other animals and of maladies resulting from non-parasitic agencies—that it is quite impossible to do more than consider a very restricted number of them in the necessarily brief period allotted to the subject to-day. It must not be supposed, however, that those perforce omitted are of no importance, for many of them may cause serious trouble and loss, especially in particular localities or under certain special conditions of soil, weather, or other circumstances that influence the crop.

Just now many farmers will naturally be concerned with the seed potatoes they are going to plant this season, although the best of them will have paid attention to this matter long ago, and will already have their seed boxed and placed under suitable conditions for sprouting. Such boxing and sprouting of seed potatoes is advantageous not alone from the points of view of increased freedom in the choice of actual planting time and ultimate gain in yield, but also because the practice offers a substantial safeguard against the planting of diseased seed. Tubers affected with Blight that still retain any viable eyes will sprout considerably earlier than others, and can thus be recognised and eliminated; for blighted tubers are the primary sources from which epidemics of Blight arise in the crop. Tubers affected with Dry Rot, a disease particularly common in early varieties, and recognisable by the concentrically wrinkled sunken areas on the skin from which dirty white or bluish pustules, composed of myriads of fungus spores protrude, can also be removed. They should be destroyed by burning, for they constitute "infection centres" from which disease may be transmitted to healthy tubers. It has been proved to be useless to cut out the diseased portions from a tuber affected with Dry Rot and plant the remainder, for it subsequently decays in the soil. It is also dangerous; for, if the healthy tubers in the same lot are cut into sets, the knife or hands will readily carry infection to them, and the result of planting them will be "misses." The Dry Rot fungus is a wound parasite, and too much care cannot be taken (especially with early varieties) to avoid mechanical damage to the tubers, both whilst lifting the crop and during its subsequent handling and transport. Too often it appears to be forgotten that potato tubers are living things; as such they deserve, but do not always get, better treat-

ment than is meted out to such commodities as coal, gravel, manures, and so forth. They require air for breathing purposes, and to fill up a closed and unventilated store to the very top with bags of them, as occurred in a case recently investigated, is simply asking for trouble. They must not be exposed to low temperatures or they will be killed, and will subsequently rot without the intervention of any parasitic organism. Nor must they become over-heated, or they will also be killed and afterwards rot ; or, if the temperature is not sufficiently high for that, become affected with Black Heart. Matters of this kind may appear trivial and relatively unimportant ; but, judging from the number of complaints arising from such ill treatment that have been referred to us in recent years, there certainly does seem to be considerable room for improvement in the way seed potatoes are treated. If they could be regarded as being almost as delicate as fruits or eggs, it would not be amiss.

Potatoes substantially attacked by Common Scab, particularly if the eyes are involved, will not be used for seed by good growers, nor will such as are affected with Powdery Scab. These two diseases are of course also contracted from the soil, and it is well to remember that even healthy seed planted in soil contaminated with either of the two Scab-producing organisms is liable to yield an affected crop of tubers, and particularly so if the soil has recently been limed. Seed potatoes showing the sclerotial incrustations of the Black Scurf fungus should also be looked on with disfavour. True, this ubiquitous fungus is very often present in potato land, but it is advisable not to augment it there. The blemish produced by the fungus on the surface of the new tubers is the least important of its maleficent effects. It is one of the more important causes of " misses " or gaps in the crop. When cold, wet conditions prevail after planting, the Black Scurf fungus readily attacks the tips of the young sprouts, underground, and kills them. The further young growth which follows as a reaction to such attack is in turn destroyed ; and thus nothing in the shape of a shoot may come above ground. On the other hand, even if young shoots do succeed in coming up, they not infrequently become cankered through by the fungus a few inches below soil level, and then wilt and die away. Trouble of this kind is most frequent in land that has carried crops of potatoes in succession for a considerable period and in which, naturally, cumulative disease effects are only to be expected. The remedy is obvious, but too often neglected.

Skin Spot is a disease that needs special attention, for it has caused a great deal of trouble in recent years. It can be recognised on the tuber in the form of small, circular, dark spots on the skin, usually having a slightly raised, minute, pimple in the centre. Often the spots are very numerous and confluent, giving a pock-like appearance to the skin. In ware tubers, Skin Spot, though objectionable, might, perhaps, be regarded more as a blemish than a serious disease, for the fungus that causes it (*Oospora pustulans*) does not penetrate

to any considerable depth into the tissue of the tuber, and it is completely removed on ordinary peeling. With seed tubers, however, the matter is very different. The fungus attacks the individual buds in the eyes, and kills them. The severity of attack appears to depend largely on external conditions. Even during winter storage the buds may be killed to some extent, but, fortunately, the potato has the capacity (not unlimited, it is true) of forming new buds in its eyes to replace those lost. The struggle between host and parasite does not cease when the tuber is planted. If the soil is in good condition and the weather and other circumstances are favourable to the potato, then the unattacked buds will soon become large enough and sufficiently robust to resist attack by the fungus. On the other hand, when the soil is ill drained and not well tilled, and particularly when cold, wet weather conditions prevail for any length of time after planting, the fungus gains the upper hand, kills bud after bud as they successively arise, until the tuber may eventually become entirely "blind." It then produces nothing above ground, of course, but it is not actually dead. Unless attacked by some other enemy, the blind tuber produces at its heel end, where it was originally attached to its stolon a rather hard, woody, tumour-like growth. Blind seed tubers, each with a basal tumour of this kind, are not infrequently found at digging time in a gappy drop derived from seed affected with Skin Spot, and the tumours have sometimes been wrongly suspected as having been caused by the Wart Disease organism. They are still alive, so reluctant is the potato to give up the ghost entirely; and, on replanting them under favourable conditions, adventitious buds are formed on the tumours, which develop into normal foliage-bearing shoots. Seed potatoes showing Skin Spot, therefore, should be regarded with great suspicion. Under unfavourable conditions they are almost certain to give rise to real trouble, and no one can predict with certainty what conditions are likely to prevail after planting. The conditions existing when seed potatoes are properly sprouted in boxes are advantageous to the potato and not to the Skin Spot fungus. If, therefore, sprouting seed potatoes were a universal practice less would be heard of failures of crops due to this disease.

What has been said so far in regard to troubles that may arise from faulty seed potatoes refers to matters that are discernible by careful examination of the tubers. Unfortunately, there are other diseases transmitted with seed potatoes that afford no signs whatever of their presence; and the chief of these are most of the virus diseases. In practice, judging from reports received, the most important of these from the point of view of general reduction in yield is Leaf Roll. Mosaic and Crinkle probable come next, and the various forms of Streak last. This order, however, does not represent the relative virulence with which these diseases attack potato plants themselves, for Streak and the severe forms of Crinkle may be so intense in their effects that the affected plants may be practically wiped out, and

thus few or no tubers that could find their way into commercial seed remain.

The nature of plant viruses is still an unsolved problem, but that those affecting the potato are carried in the seed tuber and that they are transmitted from diseased to healthy plants by insects is unquestionable. Fortunately, however, they do not appear to be carried in the true seed, developed in the so-called potato "plum" or "apple"; and thus the production of virus-free potatoes, for breeding or other purposes, is not an impossibility.

Attempts have been made from time to time to find a ready method of distinguishing between healthy seed potatoes and those derived from virus-attacked plants, but so far without much practical success. In the United States of America a so-called "tuber-index" method of testing seed potatoes for the presence or absence of virus has been developed and practised to some extent. This consists in removing a portion of the tuber containing an eye, planting it in a greenhouse in the winter and noting the state of health of the shoots when they are some eight inches or so high. Those tubers alone are retained for planting, the portions from which have given rise to shoots showing no virus symptoms; and from them relatively healthy stocks can be worked up, provided this is done under isolated conditions, where virus infection from without is not possible or is at a minimum. No doubt, for the raising of special stocks of seed potatoes this method of controlling the health of them is valuable, and particularly so if, as seems to be the case in America, the tuber-indexing can be done for the raiser by a public institution. For the ordinary farmer, however, the method is scarcely practicable.

Attempts have been made recently in Germany to discriminate between healthy and degenerate (*i.e.*, presumably, virus-containing) potato tubers by electrical measurement methods. Arising out of these a so-called copper-strip test has been devised. A bright strip of copper about the size of a pen-knife blade is pushed well into the end of the tuber, which is then kept for about eight hours at a temperature of 37-40 degrees C. After a further sixteen hours at about 20 degrees C., the tuber is cut across. If it is a healthy one there should be a black stain extending for a considerable distance around the slit-like wound made by the copper strip. If it is a degenerate one there should be no such stain, or at most one not extending much beyond the edges of the wound itself. The method seemed so simple as to be worth a trial, hence one was made with tubers known to be derived from plants affected with Leaf Roll and with others that were believed to be healthy. The result, however, was that the tubers affected with Leaf Roll showed the extensive blackening supposed to occur only with healthy tubers; thus, for this particular disease, at any rate, the method appears to be useless. Others have made similar preliminary tests and have also found the method not promising for distinguishing tubers containing virus from healthy tubers.

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For the supply of seed potatoes as free as may be from viruses, the farmer therefore has to rely on the good faith of the seed producer, and in recent years much has been done (though much more remains to be accomplished) to raise the standard of health (particularly in regard to virus diseases) of crops of potatoes grown for seed. In Scotland, for example, growing crops showing more than a certain proportion of virus diseases, even if 100 per cent. pure (*i.e.*, true to name), are now no longer awarded official certificates for seed purposes. That really first-class seed potatoes, carrying a bare minimum of virus disease, can be raised, has clearly been shown by the successful work done in the last few years at University College, Bangor, North Wales, an account of which will be found in the Ministry's Journal for July, 1933. In principle, the plan is to start with a small quantity (in some cases, perhaps, a single plant or tuber) of material that is virus-free, or as near to this ideal as can humanly be attained, and to multiply it under rigid conditions that preclude infection (brought by insect vectors) from outside sources. In practice procedure may be slow and difficult at first, but that it can be done is certain.

The temptation to dwell disproportionately on virus diseases of the potato is extremely strong, and must be resisted, and consideration must now be given to one or two other diseases concerned with the growing plant in the field and affecting the crop of tubers raised. Blight (due to *Phytophthora infestans*) is still by far the most important of all potato diseases in this country, for it destroys the tops, reduces the crop yield and rots many of the tubers produced. Time will not permit of any detailed account of the disease now, and most of you will be thoroughly familiar with the subject. Two matters only, therefore, will be touched on to-day, namely the occurrence of primary outbreaks and Blight resistance. It used to be supposed that the first outbreaks of Blight each season always occurred in the extreme south-west of the country; that in due course infection spread from them eastwards and northwards, in wave-like fashion, the rate of progression of the wave depending largely on weather conditions. For the past ten years or so records have been kept of the dates and localities of the first seasonal outbreaks of potato Blight, and they show that this wave of disease does not in fact exist. Although, of course, mainly owing to climatic conditions, the very earliest outbreaks generally do occur in the south-west and the latest in the north, yet, broadly speaking, outbreaks occur at numerous centres widely distant from one another and at no very widely different dates. A single stone thrown into the water at the edge of a pond will produce a wave (or a succession of parallel waves) that will progress until it reaches the edges and far end of the pond, the whole surface having been traversed from the one original source of disturbance. If a handful of pebbles is broadcast into the pond, however, each will give rise to a circular wave; and these circles will expand and run into one another until eventually the whole of the

surface of the pond will have been wave-traversed. If the whole handful is scattered not at one time, but distributed bit by bit, at comparatively short intervals of time, the whole surface will also eventually be wave-traversed; and this is the kind of picture to bear in mind when considering the seasonal inception and spread of potato Blight here. The practical bearing of this analogy is that when a farmer hears that Blight has once more put in its annual appearance somewhere in the country he should not wait for the advance of any wave of disease from a distance, but realise that it may be practically at his own door already and act accordingly. Each season, as soon as potato Blight has occurred again, in whatever locality, the Ministry of Agriculture makes the fact known as widely as possible through the press and by other methods of publicity. The warning is repeated as further outbreaks are reported, and thus farmers are reminded that the time has arrived when spraying potatoes with Bordeaux or with Burgundy mixture should be undertaken.

One point in connection with the records deserves to be mentioned. It is the comparative frequency with which the first outbreaks occur in proximity to old potato pits or clamps. It is known, of course, that the Blight fungus overwinters in the tubers, and, it is believed, in them alone. Blighted tubers thrown out of a pit and left lying about are naturally dangerous sources of infection to neighbouring potato crops, for the fungus fructifies on them, and the spores produced are readily disseminated. Much could be done to retard and minimize outbreaks of Blight by paying stricter attention to plant sanitation and hygiene and thus suppressing foci from which primary infections arise. Moreover, more could be done than is often attempted to minimise attacks of Blight on the tubers by adequate and careful earthing up of the drills.

A potato variety resistant to or immune from Blight attack has for generations been a desideratum, and many attempts have been made to secure one. Nor have they been entirely unsuccessful, for a few varieties resistant both in haulm and tuber do exist. Unfortunately, however, they do not possess many of the other important characteristics that are bound up with a commercially valuable sort, and they have therefore not come into general favour. Some of them are late ripening varieties, but one of them at least is an early one, and their resistance cannot be explained (as is sometimes supposed) by the assumption that they merely escape infection because they are not in a suitable stage of development for attack when the Blight fungus is active. Their resistance appears to be constitutional or inherent. Renewed attempts have been made during the past ten or twelve years, particularly in Germany, to raise a Blight-resistant variety that will be satisfactory from other points of view, and acceptable to the commercial potato grower. Failure to produce such a variety by breeding from already cultivated varieties alone led to the use by breeders of one or two highly resistant wild species of potatoes, as parents in crosses with cultivated varie-

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ties. A few new varieties were thus raised possessing, apparently, resistance and many or most of the other required characteristics, and the prospects seemed particularly good. Alas, however, when these varieties were sent out, after a few years, for wider trial they broke down, and became attacked by Blight. This happened successively with two sets of specially promising progenies, but there still remains a third set not yet fully tried out. The resistant wild species *Solanum demissum* is concerned in the derivation of this third lot, but there appears to be no obvious reason why the progenies raised from it should ultimately behave differently from those raised with the help of other resistant wild species. Such disasters are of course almost heart-breaking to the breeder, and the question is: how do they come about? The answer is that it is now thought that the Blight fungus exists in the form of more than one "biological species" (just as the Rust fungi do), and that a variety resistant to one biological species may be attacked by a different one. Further and very critical work is required before this belief can be regarded as based on an unshakable foundation; but if it should prove to stand fast, then the breeder's task is made a hundredfold more difficult; for a variety will have to be raised that resists the attack not only of those "biological species" of *Phytophthora infestans* that already exist, but also of others that may possibly come into existence in future.

There is another important aspect of the Blight resistance problem that may be alluded to in passing; there is unfortunately no time to deal with it adequately now. It is the question as to whether resistance, even if it appears to be inherent or constitutional, is necessarily really permanent in the variety. Can external factors so influence the potato plant that Blight resistance becomes weakened or even entirely lost in the course of years when the variety comes into general cultivation? The scientific breeder will probably answer no, if resistance is really bound up with the gene (the supposed material unit of the cell that carries the heritable characteristics of the plant), and seeing that propagation is entirely vegetative; but it will be up to him to demonstrate beyond doubt that Blight resistance is or can be so linked up and remain absolutely permanent.

It may now be well to turn from this perhaps somewhat depressing picture of Blight-resistance and its practical possibilities to that of resistance to a totally different disease, a picture of a much more cheerful and satisfactory aspect, namely, resistance to Wart Disease. Here it can be said that the existence of some old and the raising of certain new resistant varieties has been of immense practical importance to the farmer. Thanks to them and to the administrative measures governing their employment the losses due to this disease in this country are now entirely negligible, although discovered foci of soil infection have not ceased to accumulate slowly. This satisfactory state of affairs, however, must not lead to diminished care or to neglect of the precautions that have led to this happy result,

for the menace still remains. The careful work of recent years has shown that potato varieties can be arranged in a series, starting with those that are extremely susceptible to Wart attack, passing through those that are less susceptible, to some that are somewhat resistant; then to others definitely resistant, highly resistant, almost immune and apparently actually immune, in turn. By the use of these immune and very highly resistant varieties for planting in infected land normal crops can be grown, in spite of the fact that the parasite is still there and may remain in viable condition there for a great number of years. When breeders succeed, as no doubt eventually they will do, in producing highly resistant or immune first early varieties to replace the susceptible ones still necessarily grown in their absence, and when highly resistant or immune substitutes for such valuable main crop varieties as King Edward become available, then Wart Disease will become a matter of secondary importance. Immunity and resistance here do seem to be a permanent feature of the variety; at any rate, no authentic case of breakdown has yet been known to occur. Time and further experience alone can determine whether such a thing is possible.

To those who may have studied the historical aspects of this disease it will be of interest to mention that further light has been shed on its early history in this country by investigations recently made in Finland. There is circumstantial evidence that the disease had existed in England for some few years prior to 1900, when its presence and nature were first recognised by Professor Potter (*Jour. Board Agric.* 9, 1902-3, p. 320). It was evidently seen here (and illustrated, though not correctly identified) in 1898 by G. Abbey (*Jour. Hortic. Cott. Gard. and Home Farmer*, 3 Ser., 37, 1898, p. 463) and by A. Sutton (*Jour. Roy. Agric. Soc.*, 3 Ser., 9, 1898, p. 598). It was also probably seen, but not specifically recognised, in the same year by Wm. G. Smith (*Jour. Roy. Hortic. Soc.*, 22, 1898-99, clxxvi. and clxxviii.). These are our earliest definite records.* It was first described and recognised as a new disease, in 1896, in Hungary, by K. Schilberszky (*Ber. Deut. Bot. Ges.* 14, 1896, p. 36). Now, A. Hilli, writing in 1932 (*Perunasyövän (Synchytrium endobioticum [Schilb.], Perc.) leviämisen syistä suomessa ja ulkomailla*, Helsinki, 1932, p. 64) brings forward substantial evidence to show that Wart Disease was introduced into Finland with a consignment of Magnum Bonum potatoes from England in the year 1893. That would be five years before the disease was recognised in this country and three years before it had been discovered and described in any country. How long it may have been here prior to 1893 no one can say, but

* Since the above was written, a slightly earlier record has come to light. It is clear from the description given in an answer to a correspondent, published in Vol. 30 of the *Gardeners' Chronicle*, Aug. 22nd, 1896, p. 227, that certain potatoes showing warty growths submitted to the Editor, must have been affected with Wart Disease. Both M. C. Cooke and Worthington Smith, well-known mycologists, examined the specimens and agreed that this manifestation of disease was a novelty.

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had we possessed a phytopathological service in this country forty years ago, how much trouble might have been avoided !

Finally, although strictly speaking insect pests do not come within my special province, but are dealt with by my entomological colleagues, something must be said about the existing Colorado beetle menace to this country. It is scarcely necessary to emphasise the enormous damage that this insect and its grubs can do to potato crops by devouring the tops ; this is well known. In general shape and appearance the beetle reminds one of a lady-bird beetle, but it is from two to three times larger than our commoner lady-birds, and instead of having black spots on its back, it has ten black stripes running lengthwise. In colour it is a light yellowish brown, and the soft grubs are reddish. During the last decade this pest, previously confined to North America, has become well established in France, and each year it has migrated further north in that country until now it is not far from the Channel coast. All possible practical precautions are being taken to keep the pest out of England, but an isolated case involving a few beetles was discovered last August at Tilbury. Full particulars concerning this will be found in an article by Mr. J. C. F. Fryer, Director of the Ministry's Plant Pathological Laboratory, Harpenden, who is in chief command of operations against the pest. This was published in the Ministry's Journal for January last, and in addition, an Advisory Leaflet (No. 71) on the subject, with a coloured plate, was published in the same month. A copy of this should be in the hands of every potato grower. Once before, over thirty years ago, this pest was found here ; curiously enough, also at Tilbury. It was then successfully eradicated and it is hoped and believed that the same success will crown the present efforts at extermination. However, the beetle has now become established so very much nearer to our shores than it was formerly that it is necessary to be more than ever on the alert in order to detect immediately any fresh case of invasion. Promptness of detection is essential for swift suppression. Operations against this pest can successfully be conducted only with the active assistance and co-operation of farmers and other occupiers of land. This has so far been most willingly given and will no doubt be as readily continued. Suspected specimens should be sent, packed as carefully as possible to avoid damage in the post, to The Secretary, Ministry of Agriculture, 10 Whitehall Place, London, S.W.1. On packets sent by letter post thus addressed postage need not be prepaid.

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