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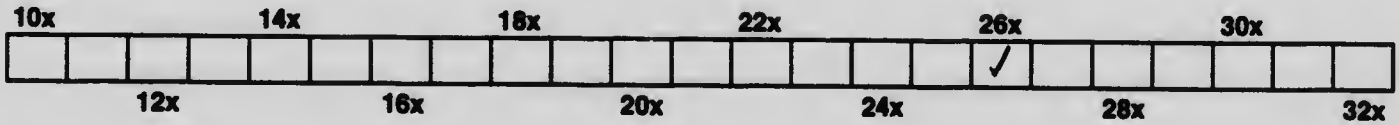

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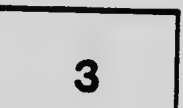

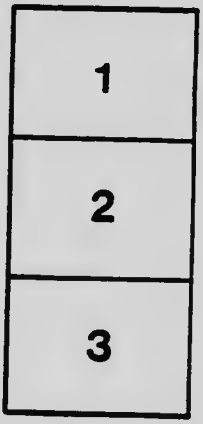

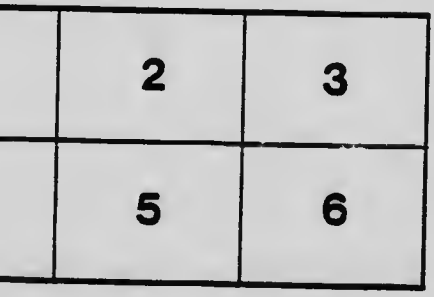

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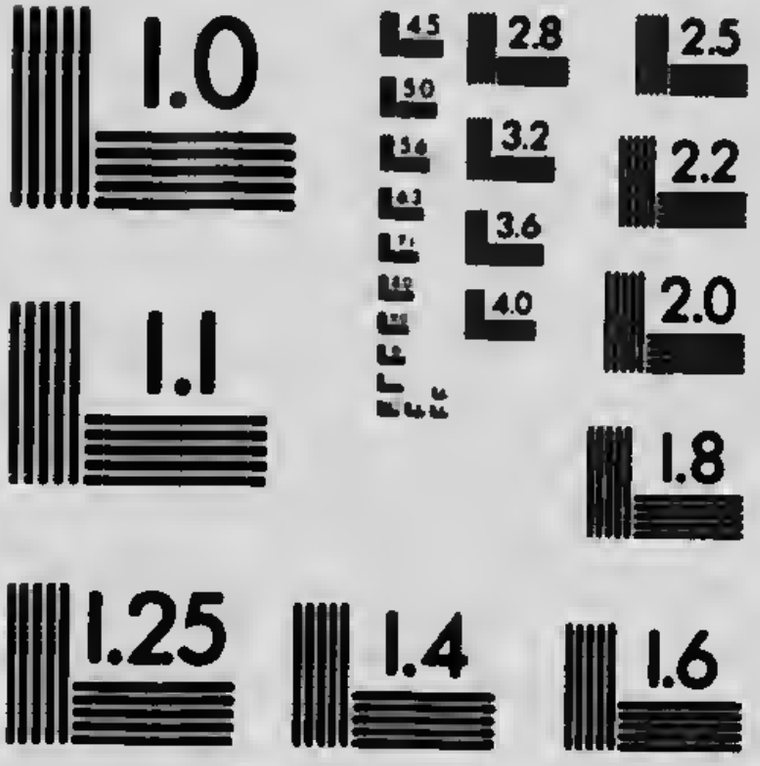

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DOMINION OF CANADA
DEPARTMENT OF AGRICULTURE
EXPERIMENTAL FARMS

DIVISION OF BOTANY.

(Farmers' Circular No. 5.)

POWDERY SCAB

OF POTATOES

(*Spongospora subterranea* (Wallr.) Johns.)

BY

J. W. EASTHAM

Chief Assistant Botanist.

Published by direction of Hon. MARTIN BURRELL, Minister of Agriculture, Ottawa, Ont.

56149—1

To the Honourable
The Minister of Agriculture,
Ottawa.

Sir,—I have the honour to submit herewith, for your approval, Farmers' Circular No. 5, entitled, "Powdery Scab of Potatoes," which has been prepared by the Assistant Dominion Botanist, Mr. J. W. Eastham, B.Sc.

The presence in Canada of the disease briefly treated of in this circular was unsuspected until a short time ago. Further, it is probable that it has been in this country but a comparatively short time. It is hoped, therefore, that the wide distribution of this circular, together with certain other preventive and eradicative measures now being planned or already undertaken, will have the effect of both preventing the further dissemination and quickly stamping out the disease.

I have the honour to be, sir,

Your obedient servant,

J. H. GRISDALE,
Director, Dominion Experimental Farms.

OTTAWA, February 9, 1914.

56149—1½

CENTRAL EXPERIMENTAL FARM,
OTTAWA, February 5, 1914

J. H. GRISDALE, Esq., B.Agr.,
Director, Dominion Experimental Farms,
Department of Agriculture,
Ottawa.

SIR,—I beg to submit for your approval a circular prepared by Mr. J. W. Eastham, B.Sc., Chief Assistant, Division of Botany, dealing with Powdery Scab of Potatoes (*Spongospora subterranea* (Wallr.) Johns.). It has been prepared at my request to meet the need for information on this disease, which has recently become of considerable importance in this country on account of the new regulations passed by the United States authorities, controlling the importation of potatoes into that country.

Mr. Eastham, from his experience in plant pathology and his close study of the disease, is well qualified to furnish such information and advice, and I entirely agree with the statements and recommendations made in this circular.

In view of the necessity for an educational campaign amongst the potato growers of the Dominion, I would recommend its immediate publication as "Farmers' Circular No. 5" of the Division of Botany.

I have the honour to be, sir,
Your obedient servant,

H. T. GÜSSOW,
Dominion Botanist

POWDERY SCAB OF POTATOES.

(*Spongospora subterranea* (Wallr.) Johnson)

With the increasing importance of the potato crop in Canada, the subject of the diseases to which this crop is liable becomes also more important, and this for several reasons. In the first place, the area devoted to the crop being greater, any disease, especially if epidemic in character, inflicts a greater total loss. Again, potato fields being closer together, there is more likelihood of disease spores being carried from one field to the other by the wind, as in the case of Late Blight, or in the soil adhering to implements, etc., in the case of certain other diseases. Where potatoes occur more frequently in the rotation, there is also more danger of the soil becoming seriously infected with the germs of certain persistent soil diseases, unless special care is taken in the selection and disinfection of the tubers used for planting. Lastly, when a surplus crop is grown and shipped to other localities, diseases may likewise become gradually disseminated over wide areas, especially by the use of infected tubers for planting. Occasionally this becomes a matter of international importance through one country believing it necessary to place an embargo on potatoes from another country, in order to protect itself against the importation of disease.

Quite recently, the passing of certain regulations by the Government of the United States has brought home to the Canadian potato growers the unpleasant consequence of having disease in their crop. Some time ago it was found that there existed in the eastern provinces of Canada, viz., Prince Edward Island, Nova Scotia, New Brunswick and Quebec, a disease of the potato tuber known as Corky, or better, Powdery Scab, which had probably been present, at least in some localities, for a number of years, but not distinguished from that omnipresent trouble of the potato grower, Common Scab.

While this disease, under Canadian conditions, has so far only in one instance given indications of being more destructive than Common Scab, it is nevertheless a very undesirable malady to have permanently established in potato-growing land. At all events the United States authorities, through fear of introducing the disease, have enacted that potatoes shall not enter the United States except under a rigorous system of certification. This includes a certificate to the effect that the potatoes were raised in an area in which neither Potato Wart (Potato Canker) nor Powdery Scab exists. As regards the former, there is, of course, no difficulty; but the latter, while not known to the growers as serious, is distributed in such a way that it is at this moment practically impossible to delimit areas which can be certified free from it. If, therefore, the export trade with the United States is to be regained in face of these regulations, it can only be done by following intelligently, and in a thorough spirit of co-operation, methods directed towards the eradication of the disease.

The Federal and Provincial Departments of Agriculture are willing to do all in their power to instruct the farmers to recognize the disease, and to take the steps necessary to stamp it out; but the responsibility for the carrying out of this advice must rest with the growers themselves. We must emphasize again the necessity for whole-hearted co-operation to this end, for if the disease exists on only one or two of the farms in a township, it means, according to our interpretation of the regulations, that the whole of this, or even a larger area, will still be under quarantine; and if one consignment of potatoes so affected is exported into the United States and the disease brought to the notice of the authorities there, a complete embargo against all Canadian potatoes is liable to go at once into effect.

We hope, however, that these restrictions will not be without some good results in the end to growers in this country. The attention which growers must now pay to the subject of the tuber diseases of this crop, and the measures it will be necessary to take against Powdery Scab will, it is confidently hoped, have the effect of reducing potato diseases in general, and of raising the standard of potato-growing in no inconsiderable degree.

NATURE AND SYMPTOMS OF POWDERY SCAB.

The first thing necessary is to obtain clear and definite knowledge of the indications which serve to distinguish this disease from others. It will then be desirable to consider, briefly, its nature and the means by which it is spread, in order that the reasons for the control measures to be afterwards given may be properly understood.

There is only one other disease with which Powdery Scab is likely to be confused, and that is the Common Scab, one of the commonest troubles of the potato grower. (See Fig. 1.) In most cases the two diseases are readily distinguished at sight by one familiar with the symptoms, but there are a certain number of cases met with, in which the use of the microscope may be necessary for complete certainty. On examining a typical case we find that the skin of the potato is raised up in circular, oval, or elliptical pustules. (See Fig. 2.) These have an even outline, and when young are covered by the smooth unbroken skin of the tuber. They may be few in number or so numerous as to cover a large portion of the surface. In the latter case several spots often coalesce to form one large scab.

A case of Common Scab compared with this stage of Powdery Scab differs in the more irregular margin of the spots, and by the surface being rough, irregular and corky, or sometimes forming an irregular pit in the surface of the tuber instead of being smooth and even.

As the Powdery Scab spots reach maturity, the skin covering them is easily broken, when there is disclosed a mass of greenish or brownish powder, from which the disease takes the name of Powdery Scab. On rubbing away this powder, it will be found that the pustule is bounded beneath by a smooth brownish membrane, which limits it quite sharply from the normal tissue. In potatoes which have been much rubbed in transportation this may be the only remaining indication of the disease. In the case of Common Scab there is no powdery mass filling the interior of the scab spot, but only a superficial irregular layer of corky cells. There is also no definite layer separating it from the underlying healthy tissue.

The powdery mass, under the microscope, is seen to consist of innumerable grains or balls of an irregularly rounded form, each of which is made up of a large number of very minute round spores, and hence termed a "spore-ball." Under the right conditions (moisture, warmth, etc.) the membrane enclosing each spore may break and the living contents of each individual spore emerge as a so-called "swarm-spore." This swarm-spore possesses, to a certain extent, the power of moving about by its own efforts, and should it come into contact with a young potato tuber may effect an entrance into one of the more superficial cells. Within the cells it undergoes certain changes, while at the same time the cell is stimulated to more rapid multiplication, so that from one or several neighbouring infections a mass of cells is formed which projects as a small wart or pustule from the surface of the tuber. Each cell of this pustule will contain one or more of the Powdery Scab organisms which have developed from the swarm-spores first mentioned ,and ultimately each of these organisms changes into one of the spore-balls with which we started. In the meantime the living contents of the potato cell have been used up by the parasite within, the cell breaks down, and the interior of the pustule becomes filled with the powdery mass of spore-balls previously described.

A little consideration of the life-history of this parasite will enable the reader to see how readily the disease may be spread, through ignorance. When a crop of potatoes affected by it has been dug, it is obvious that, in the process, many of the scab spots will have been broken open and countless numbers of spore-balls scattered in the soil, on the implements, on the shoes, hands and clothing of the workmen, and in this way may be spread from field to field. We have not, as yet, all the knowledge we desire regarding the behaviour of these spores, in particular as to the length of time for which they may remain dormant in the soil and then produce infection of a potato crop planted therein. Probably, however, considering what we know of similar diseases, they retain this power for a number of years. Until, therefore, we are in a position to say definitely how many years the disease may persist in the soil, it will be found necessary to avoid growing potatoes again on any land which has once shown this disease.

Although the disease is only known to attack the underground parts, the vines and any refuse from an infected crop should be raked together and burned. This will get rid of any adhering spores of this disease and, incidentally, of certain other pests.

The implements, containers, etc., used for such a crop should be disinfected according to instructions given at the end of this circular, before being taken to other fields, or used for other purposes.

Since no other crop is known to be liable to attack, the infected land may be put into any crop thought suitable. However, when the disease is very bad, and spores are correspondingly numerous in the soil, it is conceivable that the wind blowing over the surface of the field may catch up quantities of the spores and deposit them on land previously uncontaminated.

Where a crop is put in, there is also more danger of the germs of the disease being spread on implements if care is not taken to clean them thoroughly before taking them from one field to another. For these reasons we strongly recommend that, wherever possible, the land should be seeded down with grass or clover—a "nurse" grain crop may be used—and left in meadow or pasture for a term of years.

Still bearing in mind what has been said regarding the power of the spores to spread the disease, we must next consider the proper method of disposing of the affected crop. The worst possible means of so doing is to sell it for seed purposes to other growers. This is the most effective way of spreading the disease.

The affected crop is not injured for consumption except, according to our experience in Canada, in very rare instances. If the crop affected is a small one it may be used for domestic purposes; if larger, a part of it may be fed to stock, and it may be desirable to add a number of pigs to the live stock kept, if the quantity to be consumed is large. No potatoes from an infected crop should be fed to stock without being cooked, for there is danger that the spores may pass through the digestive organs of an animal and still retain their vitality, thus rendering the manure a means of spreading the disease.

The affected crop should be stored in pits or on the field, or, if brought indoors, should be placed in a cellar separate from the sound potatoes, with which it should not be allowed to come in contact. Similarly, any container used for the handling of infected potatoes should be kept for this purpose only. To carry a quantity of infected potatoes in a basket, and then to put sound potatoes, perhaps subsequently used for seed, in the same basket, would be to undo the effects of previous care.

If the potatoes are peeled for cooking purposes, the parings should be burned or boiled, and on no account thrown out raw to the manure-heap. If it is intended to bake infected potatoes, and they are washed first in a bucket or barrel of water, and this water then emptied out in the barnyard where it can drain away to the manure-heap, or be carried about on the feet of poultry, the seeds of a fresh crop of disease are being distributed.

It must not be forgotten that these observations apply also, though in a less degree, to the apparently sound tubers from an affected crop, as well as to tubers actually diseased.

When all the infected crop has been finally disposed of, the bins and cellars used for the storage of it should, preferably, be washed down with a disinfectant, or at least lime-washed with fresh lime. Containers, such as baskets and sacks, should be disinfected or burned.

There is at present no legal restriction on the sale of infected potatoes. It will be realized, it is hoped, that a farmer who disposes of potatoes from an infected crop without informing the purchaser that the disease is present in it, is guilty of a serious offence against the community. Should it be found that some growers are sufficiently unscrupulous to do this, it will probably lead to the enforcement of a penalty in such cases.

So far, we have considered only the procedure to be followed in disposing of an affected crop. We must now consider how the crop came to be diseased. In all cases this is due to infected soil, the only parts of the plant capable of receiving infection being those underground. We have already mentioned some of the ways in which the soil may become infected, but we cannot too strongly emphasize the fact that the chief means by which the disease is spread, is by the careless or ignorant planting of diseased tubers, or those from a diseased crop. This is, in fact, the way in which nearly all disease in the potato crop originates each year in this country. It is important, therefore, to select for seed only tubers from a healthy crop. If such seed must be purchased it should be done under a certificate or guarantee to this effect.

Apparently sound tubers from an attacked crop should not be planted, although, if carefully treated with formalin or corrosive sublimate to destroy germs adhering to the surface, the danger is perhaps not very great. We have evidence, however, that a tuber so slightly affected as to give little or no external evidence of the fact, may yet contain the living parasite within its cells and, if planted, introduce the disease. Therefore, the only absolutely safe plan is to use "seed" only from a perfectly sound crop.

Arrangements are being made whereby responsible officials of the Dominion and Provincial Governments will, upon request, inspect the crop or any portion of such a crop as desired by the grower, and give a certificate that this is free from disease and fit for use as seed.

Having secured sound seed, it should be planted in land which has never borne a crop of potatoes affected with the disease. In view of the fact that nothing is known of the presence or distribution of the disease in the past, it is impossible in most cases to say whether previous crops have been infected or not, and therefore the safe plan would be to use only land on which potatoes have not been previously grown. With our conditions here in Canada, we should be able to do this without undue hardship.

Lastly, there are certain precautions to be taken with regard to implements. In some districts it is customary for a planting-machine to be hired, and this machine goes about from one farm to another. If such a machine has been used to plant diseased potatoes on one farm, and then goes to another without having been cleaned and disinfected, it is obvious that every possible facility is being given for spreading the disease. We have evidence to show that this has actually taken place. It is, therefore, recommended that farmers should either plant by hand, use their own planter, or insist on proper disinfection of the machine before it comes on to their land. Of course, if all growers follow carefully the instructions here given with regard to the selection of "seed," one thorough disinfection of the machine at the beginning of the season might suffice, but as the negligence or ignorance of one grower in putting infected "seed" through the machine might be followed by the spread of the infection to a large area of new soil, it is best to take every possible precaution.

1. Tuber affected with Common Scab. 2. Tuber showing a mild attack of Powdery Scab. The pustules are mostly small and isolated. 3. A more serious form of the disease. The scabs are confluent and cover a large proportion of the surface. 4. Shows different appearances presented by the pustules. Those marked + have the covering membrane still intact; in those marked || the membrane has just been broken, while at O the mass of spore-balls is becoming broken up and the spore-balls scattered. 5. A much deformed tuber showing a very bad, but fortunately rare, form of the disease. (*From original photographs by H. T. Güssow.*)

DISINFECTANTS.

(1) *For seed tubers.*—These are not to be relied upon to make diseased tubers fit for planting, but only to destroy spores adhering to the surface. If sound "seed" is selected and disinfection practised, the chances of introducing Powdery Scab, Common Scab, Rhizoctonia and certain other diseases are much reduced.

(*a*) *Formalin (Formaldehyde).*—The substance, as purchased, should be guaranteed a 40 per cent solution of formaldehyde. A solution of this is prepared at the rate of 1 pound of the commercial substance to 30 gallons of water. The potatoes to be disinfected are soaked one and one-half to two hours in this solution before cutting. They are then taken out and spread on a clean floor, or on the grass, to dry. They may then be cut, if desired, and planted in the usual way. Whatever is to come into contact with the tubers after treatment, should be disinfected by being wiped down with, or immersed in, the same solution or, preferably, one still stronger. The solution may be used repeatedly, as it does not become weaker. There should always, however, be sufficient liquid to cover the tubers to be treated.

(*b*) *Corrosive Sublimate* (*Mercuric Chloride*).—This is a very powerful disinfectant, having given us better results than formalin with some organisms, notably Rhizoctonia. It is also very convenient, since it can be purchased in tablets of such a size that one, dissolved in a pint of water, makes a 1 to 1000 solution by weight. Its chief drawback is that it is intensely poisonous, and tubers treated with it cannot be used subsequently for food, as may be done, if desired, with those treated with formalin. The solution also corrodes metals, and must, therefore, be prepared in a wooden, glass, or earthenware vessel. For most purposes as a disinfectant, a solution of one part by weight in 1000 of water is employed, and this strength is commonly recommended for seed treatment, the seed being soaked for an hour and a half. We have, however, obtained better results from a 1 in 2000 solution used for three hours. The same precautions as given for formalin regarding subsequent contamination should be observed. The solution, however, becomes weaker with use owing to the absorption of the corrosive sublimate by the potatoes. The same solution should, therefore not be used more than six times.

(2) *For washing baskets, bins, implements, or sterilizing bags, containers, etc.*, the solution of corrosive sublimate (1 to 1000 strength) is reliable. Where, however, there is thought to be any danger to animals from its use, a strong solution of formalin, one pound of the commercial substance to one gallon of water, may be employed. While formaldehyde solution has a powerful local action on animal tissues, hardening the skin and irritating the mucous membrane, it is not poisonous in high dilutions. Furthermore, formaldehyde is a gas, and when the liquid has evaporated, the formaldehyde has passed off into the air, not being left behind as in the case of corrosive sublimate. For seed drills or other metal implements, which the frequent use of corrosive sublimate might corrode, the strong solution of formaldehyde may be employed, or a five per cent solution of carbolic acid. Cellars may be lime-washed with fresh quick lime, and the floors treated with chloride of lime (bleaching powder).

SUMMARY OF RECOMMENDATIONS FOR CONTROL OF POWDERY SCAB.

1. Use only "seed" from a crop free from the disease.

2. Disinfect such "seed" to destroy any stray disease germs.

3. Use land known to be free from the disease. In most areas this will have to be land not previously planted to potatoes.

4. Do not plant potatoes again in land which has shown the disease. If possible seed such land down to grass.

5. Isolate the crop from any field showing the disease, and take all possible precautions to avoid the spores from this crop being scattered where they may infect other potatoes.

6. Pay special attention to the cleaning, and, if necessary, disinfection of implements which may carry the disease.