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THE MOSAIC DISEASE OF THE IRISH POTATO AND THE USE OF CERTIFIED POTATO SEED

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The Mosaic Disease of the Irish Potato and the use of Certified Potato Seed.

C. W. Edgerton and G. L. Tiebout.

The disease of Irish potatoes, known as the mosaic disease, or sometimes locally as the curly leaf, is the most important potato disease in Louisiana. It occurs in every section of the State where the Bliss Triumph variety is grown and frequently causes a very heavy loss. A loss of fifty per cent or more is not at all uncommon and occasionally the crop in some fields is a total failure. During the season of 1921, a great many growers did little better than to get their seed back.

APPEARANCE OF THE DISEASE.

The appearance of the mosaic disease varies to some extent, depending upon the season, severity of the attack and other factors. Two forms or stages of the disease are commonly recognized, these being commonly known as the curly leaf stage and the dwarf stage. These are not distinct forms, however, as there are intermediate stages between them.

The most characteristic symptom of the disease is the curly or uneven appearance of the leaves (Fig. 1). There may be slightly raised blister-like areas on the leaves or there may be merely an uneven, curly or wavy appearance to the leaf surface. In most cases, the raised portions are darker green in color than the rest of the surface, this giving the leaf more or less of a mottled appearance. This mottling, however, is not always evident.

The leaves of affected plants are also generally slightly lighter in color than those of healthy ones. In a badly infected field, the light color is usually evident by looking across the field. Mosaic plants also have other characters which are noticeable after one becomes acquainted with the disease. The leaves on affected plants are usually smaller and generally stand more upright than on healthy ones and the whole plant has a more open appearance. Plants with the curly leaf stage of the disease may often be as large as healthy ones; such a plant is shown in Fig. 2. In the dwarf stage, however, the internodes between the leaves are much shortened, the leaves are small and the whole plant remains small and dwarfed. It is the dwarf stage that
usually attracts the notice of the grower. Plants in the dwarf stage produce only a few small, unmarketable tubers. Plants in the curly leaf stage produce some good tubers but the yield is much less than with healthy plants.

The loss from mosaic seems to be much greater in Louisiana than in the northern potato-growing districts. This is probably due to the higher temperature. It is a well recognized fact that if there is any mosaic infection in the seed, the disease will quick-

![Figure 1. On the left, a potato leaf affected with the mosaic disease; on the right, a healthy leaf.](image)

ly show up when potatoes are planted in the South. In the northern states, there are records of high yields even with a considerable mosaic infection, but this is not the case in the South. The plants seem to be weakened by the disease and the hot weather causes them to go to pieces. Frequently in hot weather, the leaf tissue of affected plants will break down and die while no such condition is noticed on healthy plants.

The temperature also has an effect on the appearance of the disease. Often in the cool early spring, affected leaves will have a very decided mottled appearance, while this is very rare later
in the season. During the warm weather, late in the season, the leaves only show the pale color and the curly effect.

THE MOSAIC DISEASE IN LOUISIANA.

The mosaic disease has been known in Louisiana for a considerable period. Specimens of the dwarf stage were noticed in a field at Baton Rouge in 1909. This was before the time that the mosaic was recognized as a disease. At that time, it was thought that the dwarfing was due to a deterioration or running out of the seed. It is probable that the disease has been in the state for a much longer period.

VARIETIES AFFECTED.

Different potato varieties show a marked difference in regard to their susceptibility to the mosaic disease. Some varieties are very susceptible and are injured very badly, while other varieties are not affected at all or at least but slightly. Of the varieties grown in Louisiana, the Bliss Triumph is the only one that is
seriously affected. Other varieties like the Irish Cobbler, White Star and Burbank are not injured by the mosaic. The Bliss Triumph, however, is used to a greater extent in Louisiana than any other variety. It is an excellent early market potato and if it were not for the mosaic, it would be almost an ideal variety for Louisiana conditions. It is earlier, yields better and sells better than the other varieties which have been tried.

It may be that the ultimate solution of the mosaic problem will be the complete elimination of the Triumph potato. In the Bayou Lafourche region, this has already practically been accomplished. Formerly in that region, the Triumph was the principal potato, but on account of the heavy losses caused by the disease, the growers gradually replaced it with white varieties which are immune to the disease. However, the Triumph potato has so many good qualities that it would be unwise to stop growing it if there is any other solution to the problem.

CAUSE AND DISSEMINATION OF THE MOSAIC DISEASE.

The cause of the mosaic disease has never been discovered. It is like a number of human and animal diseases in this respect. A great deal is known about how it acts and spreads from plant to plant but no one has been able to determine the actual cause. The disease is very contagious or infectious. Under favorable conditions, the disease spreads very rapidly from plant to plant. A little juice from an infected plant placed in the tissues of a healthy plant under the right conditions, will result in a mosaic infection.

Apparently after a plant once becomes affected it always remains affected. As far as is known, it never outgrows the infection or becomes immunized to it. Furthermore, the tubers which develop on an infected plant, contain the disease and if these tubers are planted the young plants which develop from them will be infected.

Under ordinary field conditions, the disease seems to be largely transmitted by insects. Sucking insects, such as plant lice, feed upon diseased plants and then fly to healthy plants, carrying the infection with them.
PRIMARY AND SECONDARY INFECTIONS.

With the mosaic diseases like the potato mosaic, it is usual and important to distinguish between what are called primary and secondary infections. A plant that receives the disease from the infected seed piece is said to have a primary infection. The disease shows on the plant when it first comes through the ground and stays with it through the whole season.

A plant growing from a healthy seed-piece and healthy when it comes through the ground but later becoming infected during the growing season, is said to have a secondary infection. With secondary infections, the disease only shows on those leaves that develop after the plants become infected. Under Louisiana field conditions, it is usually possible to recognize the plants with secondary infections as the basal or bottom leaves will be perfectly healthy while the upper leaves will show the mosaic or curly appearance.

There is a marked difference in the yield of plants with primary and secondary infections. Usually secondary infections do not decrease the yield to any marked extent, most of the reductions in yield being due to primary infections. Consequently, the secondary infections do not matter to the Louisiana grower unless he expects to use the tubers for planting a fall crop.

Many growers make a practice of growing a fall crop from potatoes they have raised in the spring and then using the tubers grown in the fall for the main planting the following spring. This system has given very good results in some instances but all growers recognize that the strains soon run out. They have found by experience that it is necessary to discard their home seed after a year or two and bring in fresh seed from the northern states. The main reason for the running out seems to be the increased infection of mosaic. Fields of potatoes raised from home-grown seed in the Alexandria district during 1921 had mosaic infections ranging from fifty to ninety-five per cent. The fields with mosaic of ninety per cent or more, made practically nothing.
MOSAIC CONDITION OF COMMERCIAL UNCERTIFIED SEED.

The Louisiana grower of Triumph potatoes has been working under a considerable handicap because he has had to depend largely upon northern grown potatoes for his seed. As there is no way of telling the mosaic in the tubers, he has been compelled to buy seed potatoes on the market and trust to luck that they were not too badly affected with the mosaic; and too frequently, the luck has been against him. Only in the last few years, has it been possible to obtain any information about any seed on the market.

The common commercial uncertified seed which is shipped into Louisiana is, as a rule, extremely poor. Occasionally a good lot of seed finds its way into the state but it is the exception. Such a lot of good seed was obtained at Alexandria during 1921. Fields from this seed showed a mosaic infection of only about three to five per cent. Usually, however, the mosaic infection in uncertified seed runs from fifty to ninety per cent. If the Louisiana grower is forced to buy his seed as he has in the past without knowing anything about it, it will be much better for him to discard the Triumph potato entirely and substitute some variety that is known to be resistant to the mosaic disease. The only hope for the Triumph potato in Louisiana in some system of certification that will enable the grower to know exactly what he is buying.

CERTIFIED POTATO SEED.

During the past few years, some of the northern states have been putting on the market what is called certified seed. As some of the Louisiana growers were severely disappointed with some of this seed, during 1921, partly due to a misunderstanding and partly due to the difficulties involved in the certification itself, it is necessary to explain carefully what is meant by certified seed.

The seed certification work was started in the state of Wisconsin several years ago, under the direction of Professor J. G. Milward of the Wisconsin State University and Experiment Station. It was the object of the work to improve the different
varieties and put upon the market the best seed that could be produced. Since the work was started in Wisconsin, other states have also taken it up. There have been many difficulties encountered in the work and today it is still far from perfect. Yet the possibilities of the work are plainly apparent.

Certified seed is grown under a system of inspection. The plants are carefully inspected in the field during the growing season and then the tubers are inspected in the bin after they are dug. There are certain standards that the potatoes have to reach. If they pass these standards the owner is given a certificate. Upon this certificate is given the health condition of the plants, the relative amount of any disease that may be present, and also information regarding trueness to type and other points of interest in the seed improvement work. These potatoes are not guaranteed to be free of any disease but the amount of any disease found by the inspectors is given in the certificate. Potatoes can have as much as thirty or forty per cent of the mosaic and still be given a certificate and sell as certified seed. Potatoes with a mosaic percentage above this, however, are not usually given a certificate. There are many points considered in the inspection work but from the standpoint of the Louisiana grower, the mosaic percentage seems to be one of the most important. Some of the Louisiana growers have not understood just what is meant by certified seed. Some have had the idea that this seed is entirely free of mosaic and consequently they have been disappointed.

During the first few years, the seed certification work was carried on and conducted largely according to the views of the producer of the seed. There was no information to show that the standards set for the northern producer were the ones that were of particular interest to the southern grower. During that period, the Louisiana Experiment Station did not recommend certified seed very strongly and would not today if the authorities in the northern states had not modified their system. There was no evidence to show that the seed which was being certified was the best seed for southern conditions. During the past few years, however, under the direction of the United States Department of Agriculture, tests with certified seed have been made
in a number of the southern states. Consequently, we have some ideas in regard to what may be expected from certified seed.

EXPERIMENTS WITH CERTIFIED SEED IN LOUISIANA.

During three years, certified and inspected lots of Triumph seed from various northern states, including Wisconsin, Minnesota, Nebraska, Michigan, Maine and other states, have been procured by the United States Department of Agriculture and sent to the Experiment Station at Baton Rouge for trial. From eight to twelve different lots of certified seed were received each year. For a check, the Experiment Station purchased on the open market four or five lots of uncertified seed from various dealers over the state. The object of the tests was to compare the certified seed with the ordinary commercial seed that the growers are in the habit of using.

It is expected that these experiments will run for five years before the complete results are published. Consequently, in this bulletin there will only be presented some general conclusions, which are more or less evident and should be known by the Louisiana grower. To make these conclusions clear, part of the results which were obtained during the season of 1921 are introduced below in tabular form. In this publication it is not necessary to give the results of the two preceding years as they were very similar to those of 1921.

In 1921, eleven lots of certified seed were received and were planted with five lots of uncertified seed in seven different plots. The duplication of plots gave a check on the work and also permitted digging at different periods. In the table below are given the results from one of the plots. There is included the source of the seed, the mosaic percentage, the total yield per acre and the yield of No. 1 potatoes. With the certified seed, the source of seed refers to the state in which the potatoes were grown; with the uncertified seed to the city or town in Louisiana in which they were purchased. The mosaic percentage was obtained from counts made by Professor Wm. Stuart of the United States Department of Agriculture on April 18, about a month before the potatoes were dug. The mosaic percentage includes both primary and secondary infections.
TABLE 1.
Tests of certified and uncertified seed at Baton Rouge in 1921.

<table>
<thead>
<tr>
<th>CERTIFIED SEED</th>
<th>UNCERTIFIED SEED</th>
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<tbody>
<tr>
<td><strong>Lot No.</strong></td>
<td><strong>Source of Seed</strong></td>
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<tr>
<td></td>
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<tr>
<td>7</td>
<td>Wisc.</td>
</tr>
<tr>
<td>10</td>
<td>Wisc.</td>
</tr>
<tr>
<td>1</td>
<td>Nebr.</td>
</tr>
<tr>
<td>9</td>
<td>Wisc.</td>
</tr>
<tr>
<td>2</td>
<td>Nebr.</td>
</tr>
<tr>
<td>3</td>
<td>Nebr.</td>
</tr>
<tr>
<td>6</td>
<td>Nebr.</td>
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<tr>
<td>4</td>
<td>Nebr.</td>
</tr>
<tr>
<td>11</td>
<td>Minn.</td>
</tr>
<tr>
<td>5</td>
<td>Nebr.</td>
</tr>
<tr>
<td>8</td>
<td>Wisc.</td>
</tr>
</tbody>
</table>

There are several important things shown by the results in the table.

First. The amount of mosaic in the seed seems to be one of the important deciding factors in the productiveness of the strains. All the low yielding strains, whether certified or uncertified, showed a high percentage of mosaic, while all of the high yielding strains showed a low percentage of mosaic.

Second. Most of the lots of certified seed, which have been tried, have been considerably better than the ordinary commercial uncertified seed.

Third. Most of the uncertified lots of seed have been very poor, showing high percentages of mosaic and very low yields. However, good lots of this seed are sometimes obtained. Such a lot was the one obtained from Alexandria, during 1921, and shown in the table. However, out of the five lots of commercial seed, only one was good; all of the rest were extremely poor. The tests show that a grower is more than likely to obtain poor seed if he is forced to buy uncertified Triumph seed on the open market.
Fourth. Some lots of certified seed may break and be as poor as any of the ordinary uncertified seed. Such a lot, No. 8, is shown in the table, (See Fig. 3). It is such seed as this that has given and is liable to give certified seed a bad name. Yet of the eleven lots of certified seed, there was only one that was really bad. When this average is compared with the average obtained with the uncertified lots, it is seen that there is a much better chance of getting good seed from certified seed than from ordinary seed. Whether by any system of inspection the northern producers will be able to entirely eliminate these bad lots of seed is at present a question.

Figure 3. Potatoes dug from two rows planted with certified seed. The five hampers on the right were from one of the high yielding strains; while the three hampers on the left were from the very poor strain that showed a high percentage of mosaic.

Fifth. There is no direct evidence to show that any one part of the country can produce better seed than other parts. Of the lots producing more than 170 bushels to the acre of No. 1 potatoes, three came from Wisconsin and three from Nebraska. The results show that the regions represented by these two states can grow good Triumph seed.

From the above it would seem that the grower has a better chance of success by buying certified seed than by buying or-
ordinary uncertified seed. The averages are certainly in favor of the certified seed. Yet the fact that seed are certified is not an assurance of success. Until the certification and inspection work becomes more nearly perfect there is always some chance of getting poor seed.

**THE SMITH STRAIN OF SEED.**

There has been another interesting development of the work. The Wisconsin authorities, watching the behavior of the Wisconsin grown potatoes in the southern experiments, have taken steps to discard all strains which are not high yielding and in other ways satisfactory. They have selected one of the best strains, now known as the Smith strain, and are placing this in the hands of the Wisconsin growers who are growing certified seed. It is interesting to note that the two lots of certified seed ranking first and second in the 1921 experiments at Baton Rouge were of this Smith strain. It would seem that if the Wisconsin growers are able to keep the mosaic percentage low, they will be able to make a permanent improvement in their certified seed by this method.

**GROWERS' TESTS OF CERTIFIED SEED.**

It is recognized that the supreme test of any seed is the test made by the users of that seed. Unfortunately, we do not have a great amount of information on that subject. Previously to 1921, there had been but little certified seed used in the State of Louisiana; consequently, practically all of our information comes from the 1921 trials. In 1921, a number of cars were shipped into the State and were distributed in various sections. Some of the results with this seed were good and some were decidedly bad.

In the Hammond region, a carload of certified seed, mostly of the Smith strain, was received and distributed to a great many growers. Without a known exception, every grower had excellent results. The potatoes had a very small percentage of mosaic; they grew vigorously and made high yields. The growers and dealers were very much pleased with the seed and expect to use certified seed next season.
In the Alexandria district, there was a different story. A number of carloads, all from the same man, were shipped to that point. On account of a misunderstanding, the growers did not ask for a certificate from the Wisconsin grower. They assumed that all certified seed were alike. As a matter of fact, these potatoes came from a Wisconsin field that showed a mosaic infection of thirty per cent in 1920. When these potatoes were planted in Louisiana, instead of having fields practically mosaic free, the growers found that their fields ran from seventy to eighty per cent of mosaic. The results were extremely disappointing. The highest yield obtained by any grower was twenty-six bushels to the acre, while the average yield was about ten bushels. A number of farmers did not have enough potatoes to dig. The Alexandria growers were extremely unfortunate in that they obtained a strain that broke—a strain similar to the No. 8 strain in the Baton Rouge test. To make the tests more striking, it happened that the uncertified seed that were shipped into the territory were exceptionally good. They were of the same lot of seed that did so well in the Baton Rouge test. Yields from these potatoes varied from seventy-five to one hundred and thirty bushels to the acre on five foot rows.

In the neighborhood of Ruston, some certified seed were received which, from reports, did very poorly. These potatoes also came from growers who had from thirty to fifty per cent of mosaic in their fields.

It is seen that the results which have been obtained by the growers are partly good and partly bad. All of the results show definitely that a greater consideration must be given the mosaic disease by the northern growers of certified seed if they expect to make this seed popular in the southern states.

RECOMMENDATIONS REGARDING CERTIFIED SEED.

In spite of some unfortunate disappointing results obtained by the Louisiana grower, the Louisiana Experiment Station recommends the use of this seed. While there is no guarantee with this seed that a good crop will be obtained, the averages are with it. Seventy-five to eighty-five per cent of the lots of certified seed which have been tried by the Experiment Station
have been found to be good, while less than twenty per cent of the commercial uncertified seed has been in the same class. If this ratio is maintained, the grower has about four chances out of five of obtaining a good crop with certified seed, while with the uncertified seed he seems to have only about one chance out of five.

There are several things which the growers should look into, however, before purchasing the seed. In the first place, he should demand a strain that is known to be high yielding. If he buys in the Wisconsin region, he should demand the Smith strain. There are probably other strains in Wisconsin that are just as good but there is no definite information about them. Until the other strains are proved to be good, the Louisiana grower should take no chances, but should demand the Smith strain. According to Professor J. G. Milward, a considerable number of the Wisconsin growers are and will be using this strain.

In the second place, the Louisiana purchaser of certified seed should demand a copy of the certificate issued to the northern producers. Upon the certificate will be given the amount of mosaic found in the field in which the seed were grown. If the percentage of mosaic runs high, it should not be purchased. It is doubtful if seed are safe, if the mosaic percentage runs above ten or fifteen per cent.

It is believed that if these two points are looked into before purchasing seed, there will be a better chance of obtaining good seed. Yet, with all of these precautions, the growers must appreciate that we are only figuring on averages and there may be times when the seed that have all the appearances of being the best, may break and be as poor as any of the commercial strains. Yet it is firmly believed that these times will be far less frequent than they have been in the past with the uncertified seed which the growers have been forced to buy.

Certified seed should also be treated with formaldehyde for scab, just the same as uncertified seed. While certified seed usually contains only a small percentage of scab, there is always enough present to necessitate the formaldehyde treatment.