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Claude Wilbur Edgerton

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Delayed Ripening of Tomatoes Caused By Spraying With Bordeaux Mixture

By

C. W. EDGERTON, Plant Pathologist
DELAYED RIPENING OF TOMATOES CAUSED BY SPRAYING WITH BORDEAUX MIXTURE

C. W. Edgerton

In the tomato-growing sections of Louisiana, the foliage of tomatoes is always more or less affected with two diseases, these generally causing a partial defoliation of the plants and sometimes a complete defoliation. The two diseases are the Early Blight, caused by the fungus, *Alternaria solani*, and the Leaf Mold, caused by the fungus, *Cladosporium fulvum*.

The Early Blight may affect all parts of the tomato plant above ground, including the leaves, stems and fruit. The disease first appears in the form of small brown or black spots on the leaves, especially the lower ones. These spots are scattered and inconspicuous at first but later increase in size and number. If the seasonal conditions are favorable, these spots finally cover the leaves and cause their death. Similar appearing spots may also develop on the stems and fruit.

The Early Blight appears in three degrees or conditions of severity and the recognition of these is essential for the understanding of the results of the experiments described in this bulletin. *First*, the disease may be confined to the lower leaves of the plant, causing the death of these but not spreading to any extent to the upper leaves. This is apparently the usual condition in Louisiana, this condition occurring more often than both of the other conditions together. *Second*, the disease may spread from the lower leaves to the upper ones but not to the fruit. This results in a complete defoliation and death of the plants. While the fruits are not specked, they ripen while hanging on the dead plants and are not of the best quality. Such a condition occurred in the spring of 1918 in most parts of Louisiana. *Third*, the disease may spread to all of the leaves and also to the fruit. Not only are the plants defoliated and killed but the fruit is specked and ruined. Such a condition occurred at Baton Rouge in 1914 in the plots that were being used for the spraying experiments described in this bulletin. An extreme form of this condition occurred at Norwood in 1913, when a large percentage of the fruits in the whole district was ruined.
The Leaf Mold also appears in spots on the leaves, but these spots are very different from the ones caused by the Early Blight. The spots are slightly yellowish on the upper side of the leaf, while on the lower side they are covered with a moldy velvety growth. This moldy growth is at first light colored, but gradually turns dark. These spots spread over the affected leaves, finally causing their death. This disease is common in the state and, together with the Early Blight, is responsible for most of the leaf blighting that is commonly observed.

The general appearance of fields affected with the Early Blight, in any of its conditions of development, and the Leaf Mold would cause one to believe that these diseases produce a heavy loss and it has been the general opinion among pathologists that this is the case. As these diseases can be controlled or checked by spraying with some fungicide, such as Bordeaux Mixture, practically all bulletins and other extension literature on tomato diseases have advocated such treatment.

To test out the efficiency and value of spraying tomatoes for the control of these diseases, some tests were carried on through three seasons. The results obtained were interesting, inasmuch as they brought out a factor which is usually overlooked in spraying experiments. While the diseases were readily controlled by spraying with Bordeaux Mixture, this control was not always beneficial to the crop, and in some cases was detrimental. The spraying caused a delay in the ripening of the fruit, and this is a factor which is of extreme importance in those sections where the tomato is grown for the early market.

The experiments were conducted on the Experiment Station farm at Baton Rouge during the seasons of 1914, 1916 and 1917. During this period various weather and disease conditions were encountered, and it would seem that definite conclusions can be drawn from the data obtained. The conditions included one year with a severe infection of the Early Blight with the disease on both the leaves and the fruit, and two years with a heavy infection on the lower leaves but with very little of the disease on the fruit. The Leaf Mold infection was heavy each season.

The spraying was done in the usual manner. Bordeaux Mixture prepared according to the 4-4-50 formula was used in all of the experiments. The number and time of the sprayings are
given in the discussion of each experiment. Untreated check plots were left in all cases. Two varieties of tomatoes were used each season, one variety known to be very susceptible to the Early Blight and Leaf Mold, and one variety which is somewhat resistant. The susceptible variety was the Earliana and the resistant variety was either the Louisiana Wilt Resistant or the Globe. The Louisiana Wilt Resistant is a local variety which had been selected for resistance to the Fusarium Wilt disease. The difference in susceptibility of different varieties is often very marked. In the season of 1918, in unsprayed fields, varieties of the Earliana type were completely defoliated shortly after the fruit began to ripen, while resistant varieties, such as the Globe, kept their foliage throughout the season.

EXPERIMENTS IN 1914

The first spraying experiment was carried on in the spring of 1914. This was a season with a very heavy infection of the Early Blight, the disease occurring on both leaves and fruit. The two varieties used in the experiment were the Earliana and the Louisiana Wilt Resistant. One plot was left unsprayed as a check. Another plot was sprayed six times at intervals of ten days, the first spraying one week after the plants were set in the field and the last spraying at the time of the first picking. A third plot was sprayed only twice, at the time of the last two sprayings of the second plot. The results of the experiment are shown in Figure 1 and Table 1. The curves in Figure 1 show the amount of fruit picked each week from the check and sprayed plots, the yield being figured on an acre basis. The total yield of fruit is given in Table 1.

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**TABLE 1**

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Earliana Yields, lbs.</th>
<th>Louisiana Wilt Resistant Yield, lbs.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Check</td>
<td>18,930</td>
<td>13,770</td>
</tr>
<tr>
<td>Sprayed six times</td>
<td>29,520</td>
<td>14,060</td>
</tr>
<tr>
<td>Sprayed two times</td>
<td>24,700</td>
<td>11,950</td>
</tr>
</tbody>
</table>
Figure 1. Results of tomato spraying experiments in 1914. I. Variety Earliana. II. Variety Louisiana Wilt Resistant. A. Curves showing the yield per acre at weekly pickings on unsprayed plots. B. Same on plots sprayed six times with Bordeaux Mixture. C. Same on plots sprayed two times with Bordeaux Mixture.
In the tests in 1914 with the Earliana variety, the total yield of the plots sprayed six times was very much larger than of the unsprayed plots. The curve of production in Figure 1 also shows the weekly pickings of the sprayed plots to be greater. Of all the six experiments discussed in this bulletin, this was the only one in which the yield of the first few pickings of the heavily sprayed plots was greater than of the unsprayed. This was due to the heavy infection of the Early Blight on the fruit of the unsprayed plots. A large portion of the fruit on these was ruined by the disease. When the disease threatens to become severe on the fruits, there is no question but what spraying is advisable. The effect of spraying the plants only twice is also very noticeable. The two late sprayings checked the disease and prolonged the picking season for a considerable time.

In the tests with the Louisiana Wilt Resistant variety, different results were obtained than with the Earliana. This tomato is fairly resistant to the Early Blight and there was not very much fruit infection. The difference in yield of the treated and check plots was not enough to be noteworthy. It should be noted, however, that the check plot gave a greater yield at the heaviest picking than the treated ones. While the difference is not very marked, it is noteworthy, as it is in accord with the results of the preceding years.

**EXPERIMENTS IN 1916**

The season of 1916 was one with a heavy infection on the lower leaves but with very little on the upper leaves or fruit. The leaves were practically all killed on the lower portions of the plants. The two varieties used in the spraying experiments during this season were the Earliana and Globe. The treated plots were sprayed nine times at intervals of ten days, the first spraying shortly after the plants were set in the field and the last spraying at the beginning of the fifth week of the picking season. The results of the experiment are shown in Figure 2 and Table 2. The curves show the amount of fruit picked each week from the check and sprayed plots, the yields being figured on an acre basis. The total yield of fruit and the percentage that was marketable are given in Table 2.
Figure 2. Results of tomato spraying experiments in 1916. I. Variety Earliana. II. Variety Globe. A. Curves showing the yield per acre at weekly pickings on unsprayed plots. B. Same on plots sprayed with Bordeaux Mixture.
The season of 1916 was a very satisfactory year for the tomato grower; in fact, it was called a very good tomato year. The weather was favorable and the picking season was extended through seven or eight weeks. Perhaps the season could be called more nearly normal than either of the other two years in which the spraying was carried on. On this account it would seem that the results obtained would approach closely to what we would expect for a series of years.

The results of the spraying experiments in 1916 show a slightly greater total yield on the sprayed plots but the difference is not very marked. It should be noted, however, that the difference is greater with the susceptible variety, Earliana, than it is with the resistant variety, Globe.

What stands out most prominently in the 1916 experiments is the delay in the ripening of the fruit caused by spraying and the increase in yield of the unsprayed plots at the early pickings. This is brought out well by the curves in Figure 2. The curves of production show the first few pickings of the unsprayed plots to be much heavier than of the sprayed plots, while the later pickings show the reverse. With the Earliana variety, the second week gave the maximum yield of fruit on the unsprayed plots, while the maximum was not reached on the sprayed plots until the fourth week. To the early market gardener, the yield of the first few pickings is often of more importance than the total yield of fruit.

**EXPERIMENTS IN 1917**

The third and last set of spraying experiments were run during the spring of 1917. The varieties were the Earliana and Globe, the same as in the preceding year. Although the season was unusually dry, there was a heavy infection of the Early Blight and Leaf Mold on the lower leaves but not much upon the

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**TABLE 2**

**YIELD OF TOMATO PLOTS IN 1916**

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Earliana</th>
<th>Globe</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Yield, lbs.</td>
<td>Per Cent Marketable</td>
</tr>
<tr>
<td>Check</td>
<td>15,865</td>
<td>39</td>
</tr>
<tr>
<td>Sprayed</td>
<td>18,585</td>
<td>40</td>
</tr>
</tbody>
</table>

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Figure 3. Results of tomato spraying experiments in 1917. I. Variety Earliana. II. Variety Globe. A. Curves showing the yield per acre at weekly picking on unsprayed plots. B. Same on plots sprayed with Bordeaux Mixture.
upper leaves or fruit. As a result of the dry season, there was a
great deal of Blossom End Rot, but this trouble seemed to be
equally abundant on the sprayed and unsprayed plots and so
has no particular effect on the results obtained. The treated
rows were sprayed five times, the first time about three weeks
after the plants were set in the field and the last time at the time
of the first picking. It had been the intention to continue the
spraying through the picking season, but the dry weather injured
the plants so severely that it did not seem worth while. This
was unfortunate, as late rains revived the plants, caused new
growth and the setting of a second crop of fruit. The early
spraying had but slight effect on the ripening of this second
crop.

The results of the experiments of 1917 are shown in Figure 3.
The curves show the amount of fruit picked each week from the
check and sprayed plots, the yield being figured on an acre basis.
The total yield of fruit and the percentage that was marketable
are given in Table 3.

**TABLE 3**

<table>
<thead>
<tr>
<th>Yield of Tomato Plots in 1917</th>
</tr>
</thead>
<tbody>
<tr>
<td>Earliana</td>
</tr>
<tr>
<td>--------------------------</td>
</tr>
<tr>
<td>Yield, lbs.</td>
</tr>
<tr>
<td>Check</td>
</tr>
<tr>
<td>Sprayed</td>
</tr>
<tr>
<td>Per Cent Marketable</td>
</tr>
<tr>
<td>Per Cent Marketable</td>
</tr>
</tbody>
</table>

Again in 1917, the yield of the check or unsprayed plots at the
first pickings was greater than that of the sprayed plots, this, as
usual, being more marked with the susceptible variety, Earliana,
than with the resistant variety, Globe.

Also in this test, the total yield for the season was greater on
the unsprayed plots than on the sprayed. This seemed to be due
to the two factors: delayed ripening caused by the Bordeaux
Mixture and the abnormally dry weather, working together. In
normal seasons, it would have been expected that the curve of
weekly production of the sprayed plots would have crossed the
curve of the check plots by the end of the third or fourth week,
but the drought checked the development of the fruit and pre-
vented this. As the fruit on the sprayed plots developed slower,
it was consequently injured more by the dry weather than was the fruit on the unsprayed plots. The drought was broken at the end of the fifth week of the picking season and the plants then developed a new crop. As the spraying had been discontinued at the first picking, the effect of the spray solution on this second crop was greatly reduced; in fact, upon the Earliana it was practically negligible.

**DISCUSSION OF RESULTS**

Considering the three years as a whole, it is found that in all cases, with the exception of the first year with the Earliana variety, the unsprayed plots have given a considerably larger yield than the sprayed plots during the early pickings. The decreased yield of the sprayed plots seemed to be due to the checking of the various leaf blights which occur on the tomato plants. Under ordinary unsprayed conditions, a considerable amount of the foliage, especially the lower leaves, is killed or badly injured by the Early Blight and Leaf Mold. This partial defoliation of the plants causes a more rapid development of the fruit in the same way as severe pruning will do. Holding this foliage by means of sprays produces a greater vegetative growth and slower development of the fruit.

This delayed ripening of the fruit is of considerable importance in regions where the tomato is raised as an early truck crop. The early fruit usually sells at a much higher price than the late crop and a delay in ripening may mean a considerable loss to the grower. For the grower of early tomatoes, the total amount of fruit is often not as important as is the time when the fruit is produced. To the person who is growing tomatoes in a home garden for his own use or for canning, delayed ripening of the fruit is not of so much importance. In fact, an extension of the picking season may be in many cases desirable.

The difference in the total amount of fruit produced on the sprayed and unsprayed plots was not very marked. During the first experiment, in a year in which there was a heavy fruit infection of the Early Blight, there was a considerable reduction in yield in the unsprayed plots of one variety, but this was partially offset by the results obtained in 1917. In the latter year, the sprayed plots produced less than the unsprayed, due to the excessive dry weather. The percentage of marketable fruit was also not very different on the sprayed and unsprayed plots.
Figure 4. Tomato leaf showing a severe infection of the Early Blight in the early stages.
Considering the data obtained, it seems as if we should modify the recommendations which are generally given for spraying tomatoes, especially tomatoes that are grown for the early market. Heretofore, spraying has generally been advocated in order to control the leaf diseases, but our tests have shown that a limited amount of these troubles is beneficial to the crop, although an excessive infection may be quite harmful. For such years as 1914 and 1918, when the Early Blight was present on both the lower and upper leaves and was severe enough to defoliate the plants, a partial checking of the leaf troubles would doubtless have been beneficial. It would seem that if we could check these diseases to a limited extent, it would be far better than to try to control them. The obtaining of this happy medium, however, may not be as easy as it may seem. It will require a very careful watching of the plants and considerable judgment in the time and number of sprayings.

It would seem best to spray the plants in the seed bed a week or ten days before they are to be set in the field, especially if the Early Blight is present. Often the Early Blight spreads very rapidly in the seed bed, especially if the plants are crowded, and it seems best to have them in as healthy condition as possible at the time of transplanting. The disease is readily checked in the seed bed, usually one application being sufficient.

After the plants are set in the field, they should be watched very carefully. If a severe infection of the Early Blight threatens at any time during the season, it should be checked by spraying with Bordeaux Mixture. It would usually not be necessary to apply this spray until the season was fairly well advanced. The most critical time with the Early Blight is that period beginning about two weeks before the first fruits are ripe and ending when the crop is well made. It is usually during this period that the disease spreads from the lower leaves to the upper ones. If the disease does begin to develop upon the upper leaves to any extent, it should be checked with Bordeaux Mixture. The disease is readily recognized during this stage of its development. The small, dead, blackish to brownish spots (Figure 4) on the upper leaves are very characteristic. As long as the disease stays on the lower leaves, there is no cause for alarm, but when it begins to develop seriously on the upper leaves there is
danger of complete defoliation and death of the plants. A few sprayings a week or ten days apart should ordinarily be sufficient to check the disease to such an extent as to insure a crop. In 1914, two late sprayings on the Earliana variety increased the yield over the unsprayed to a considerable extent.

It has been stated on a previous page that the effect of the different diseases on the lower leaves of the plants is similar to that of pruning. Each hastens the development of the fruit. The question naturally arises, Wouldn’t it be better to prune the plants and then keep the diseases in check by spraying? There are two serious difficulties with this procedure. First, there is considerable expense and labor in thorough pruning and spraying; to keep the plants thoroughly pruned, especially in rich alluvial soils, means a considerable expense. Second, pruning is responsible for the spread of the Mosaic disease, another disease which is becoming very serious in Louisiana. As the Mosaic disease cuts down the yield of a plant about fifty percent, the serious spread of the trouble is liable to cause considerable loss. Fields have been seen in which practically every plant was affected with this disease, the heavy infection apparently being due to too frequent pruning. It is not practicable to eliminate all pruning, but too frequent pruning should not be practiced. In regions similar to that at Baton Rouge, one good pruning is generally sufficient.

**SUMMARY**

1. There are two leaf diseases of the tomato in Louisiana which are very prevalent, these being the Early Blight, caused by the fungus, *Alternaria solani*, and the Leaf Mold, caused by the fungus, *Cladosporium fulvum*. These diseases generally cause a partial defoliation of the plants and occasionally a complete defoliation. The Early Blight may also, under favorable conditions, infect the fruit, and in such favorable seasons the loss may be considerable.

2. Tomato varieties show a great deal of variation in regard to resistance to the Early Blight. Such varieties as the Earliana and June Pink are very susceptible, while such varieties as the Globe and Duke of York are fairly resistant.

3. Spraying with Bordeaux Mixture will check the leaf diseases very satisfactorily.
4. Spraying causes a delay in the ripening of the fruit which is an important factor to the man who is growing tomatoes for the early market. This delay in ripening is from one to two weeks with plants that are kept thoroughly sprayed through the season.

5. Spraying may or may not cause a greater total yield of fruit, this depending upon the season and also upon the seriousness of the infection.

6. The delayed ripening seems to be due to the greater vegetative growth of the plants. The diseases on the unsprayed plants have somewhat the same effect as pruning the plants—each results in hastening maturity.

7. As a result of the delay in ripening, the plants should only be sprayed enough to check the diseases during very serious epidemics. It does not seem advisable to try to control the diseases entirely.

8. It is better to let the diseases partially defoliate the plants than it is to remove this same foliage by pruning. Pruning tends to spread another trouble, the Mosaic disease, which promises to become very serious in Louisiana. Pruning is often desirable, but should not be practiced more than necessary.