SPRAYING IN 1897 TO PREVENT GOOSEBERRY MILDEW.

C. P. CLOSE.

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†Connected with Fertilizer Control.
BULLETIN NO. 133.

SPRAYING IN 1897 TO PREVENT GOOSEBERRY MILDEW.

C. P. CLOSE.

SUMMARY.

For ten years this Station has advocated potassium sulphide as the best remedy for gooseberry mildew.

In the season of 1897 potassium sulphide, Bordeaux mixture, lysol and formalin were tested side by side.

The plantation was divided into six sections. In two of these the spraying was begun very early, just as the buds were breaking; in two others eleven days later; and in the remaining two sections twelve days after the preceding two sections.

The first mildew appeared May 26. By June 7 portions of the plantation were badly mildewed. At this date the lysol and formalin seemed to have done no good. Bordeaux mixture was more effective, but not so good as potassium sulphide where the treatments were begun very early and medium early.

All of the fruit was picked July 6 and 7 so as to market it green. Bushes sprayed very early with potassium sulphide at the rate of 1 oz. to 3 gals. of water gave only 5 per cent of mildewed fruit; those sprayed very early with it at the rate of 1 oz. to 2 gals. of water gave 6.6 per cent. Bushes sprayed very early with
lysol, 1 oz. to 1 gal. of water, gave 24.5 per cent and those sprayed very early with Bordeaux mixture gave 37.4 per cent of mildewed fruit, while the untreated bushes gave 57.7 per cent to 78.7 per cent.

The foliage was not injured by any of the fungicides.

At 18 cts. per pound for potassium sulphide, the cost of the solution which gave the best results is about one-fifth of one cent per bush for the seven sprayings.

The Station recommends potassium sulphide, 1 oz. to 3 gals. or 1 oz. to 2 gals. of water, as the most effective fungicide for gooseberry mildew.

As a rule only the English varieties and their seedlings are attacked by mildew although the American varieties are not always exempt.
INTRODUCTION.

Potassium sulphide was first used as a remedy for the powdery mildews in Europe about 1884. In 1886 it was used to a very limited extent in this country. In the following year, 1887, this Station* made the first practical test of the efficiency of potassium sulphide in combating gooseberry mildew, and although the material was not applied until the mildew was well established, the results showed that there was a beneficial effect from its use. Since then its efficiency has been proven by successive tests† and it has been recommended by the Station as the best remedy for holding mildew in check.

After Bordeaux mixture came into general use some authorities‡ advocated it as a substitute for potassium sulphide early in the season, but so far as known to the writer, these recommendations were not based on comparative tests of the two fungicides. The only record of such a comparison which he finds is that of an undecisive test made at this Station in 1892. Accordingly, in 1897, experiments were planned so as to compare them side by side. For comparison with Bordeaux mixture and potassium sulphide two other fungicides, lysol and formalin, were tried. So far as the writer has been able to find out, lysol and formalin have never before been used for this purpose.

OBJECT AND PLAN OF THE EXPERIMENT.

OBJECT.

The object of the experiment was to compare sprayings begun very early with those begun medium early and late. Bordeaux mixture and different strengths of formalin and lysol were also to be compared with different strengths of potassium sulphide.

PLAN OF EXPERIMENT.

The Industry plantation of King & Robinson, Trumansburg, N. Y., was used for the experiments. It consisted of 32 rows with 11 plants to the row. As shown by the diagram opposite, the plantation was divided into six plats. Each treatment was applied to two plats separated by plats receiving different applications. This arrangement was for the purpose of equalizing for each remedy the differences in soil and location which might exist in different parts of the plantation.

For convenience in comparing the effects of very early with medium and late spraying, three series of treatments were made. Series I was begun very early, April 12, just as the buds were breaking and successive applications were made at intervals of about ten days until seven had been given. Series II was begun April 23 when the second treatment of Series I was made. The first treatment of Series III was applied May 5 when the third treatment of Series I and the second treatment of Series II were given. During the remainder of the season the dates of treatment were the same for all applications. An untreated row was left as a check for each series.

MATERIALS USED.

Bordeaux mixture, 1 to 11 formula, was used upon one set of bushes in each series until the fruit was large enough so that spotting with the mixture would injure its sale; then potassium sulphide, 1 oz. to 2 gals. of water, was substituted for the remainder of the season.
Explanation of Diagram.

Series I.
Formalin 1 oz to 1 gal water.

Series II.
Formalin 1 oz to 2 gals water.
Formalin 1 oz to 4 gals water.

Series III.
Lysol 1 oz to 4 gals water.
Lysol 1 oz to 2 gals water.
Lysol 1 oz to 1 gal water.

Series I.
Potassium Sulphide, 1 oz to 2 gals water.

Series II.
Potassium Sulphide, 1 oz to 3 gals water.

Series III.
Bordeaux mixture.

Untreated Rows.
Potassium sulphide was used in two strengths, 1 oz. to 2 gals. of water and 1 oz. to 3 gals. of water.

Lysol and formalin were each used in three strengths, 1 oz. to 1 gal. of water, 1 oz. to 2 gals. and 1 oz. to 4 gals. These strengths were settled upon arbitrarily for trial since there were no previous experiments which might be followed as a guide.

The foliage was not injured by any of the solutions.

METHOD OF APPLICATION.

The first spraying was given with a knapsack sprayer, but this was inconvenient, especially where so many different solutions were used and the sprayer had to be washed out after each solution was applied. After the first application a bucket pump made by the Deming Co., Salem, Ohio, was tried and gave good satisfaction. With a seven-foot hose all parts of the plant could be readily reached.

DIVISION OF SERIES AND DATES OF SPRAYING.

The table opposite shows upon which rows the different strengths of fungicides were applied and gives the dates of application. The division into series is shown in the diagram opposite page 492.

RESULTS.

DEVELOPMENT OF MILDEW.

The plantation was closely watched for the first appearance of mildew and at the fifth spraying, May 26, a little was found on the fruit, especially on the untreated rows. On the treated rows there was a very slight difference in favor of the potassium sulphide treatments. All of the bushes had made a good, healthy growth and nearly all were loaded with fruit. At this time the berries were so large that potassium sulphide, 1 oz. to 2 gals. of water, was substituted for all Bordeaux mixture treatments so as to avoid having spotted fruits at the marketing season.

At the time of the sixth spraying, June 7, the entire plantation was examined to find out which treatments seemed to be most
<table>
<thead>
<tr>
<th>Bordeaux mixture* 1 to 11 formula.</th>
<th>Potassium sulphide.</th>
<th>Lysol.</th>
<th>Formalin.</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 oz. to 3 gals.</td>
<td>1 oz. to 2 gals.</td>
<td>1 oz. to 1 gal.</td>
<td>1 oz. to 2 gals.</td>
</tr>
</tbody>
</table>

**Series I. Very Early Treatment. Applications April 12, 23, May 5, 17, 26, June 7, 21.**

<table>
<thead>
<tr>
<th>Row 1, and 5 bushes of row 2 Row 17, and 5 bushes of row 18</th>
<th>Last 6 bushes of 2</th>
<th>Bushes 1-3, row 4</th>
<th>Bushes 4-7, row 4</th>
<th>Bushes 8-11, row 4</th>
<th>Bushes 1-3, row 5</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Last 6 bushes of 18</td>
<td>1-3, row 20</td>
<td>4-7, row 20</td>
<td>8-11, row 20</td>
<td>4-7, row 21</td>
</tr>
</tbody>
</table>

**Series II. Medium Early Treatment. Applications April 23, May 5, 17, 26, June 7, 21.**

<table>
<thead>
<tr>
<th>Row 7, and 5 bushes of row 8 Row 23, and 5 bushes of row 24</th>
<th>Last 6 bushes of 8</th>
<th>Bushes 1-3, row 10</th>
<th>Bushes 4-7, row 10</th>
<th>Bushes 8-11, row 10</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Last 6 bushes of 24</td>
<td>1-3, row 26</td>
<td>4-7, row 26</td>
<td>8-11, row 26</td>
</tr>
</tbody>
</table>

**Series III. Late Treatment. Applications May 5, 17, 26, June 7, 21.**

<table>
<thead>
<tr>
<th>Row 13, and 5 bushes of row 14 Row 29, and 5 bushes of row 30</th>
<th>Last 6 bushes of 14</th>
<th>Bushes 1-3, row 16</th>
<th>Bushes 4-7, row 16</th>
<th>Bushes 8-11, row 16</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Last 6 bushes of 30</td>
<td>1-3, row 32</td>
<td>4-7, row 32</td>
<td>8-11, row 32</td>
</tr>
</tbody>
</table>

* Last three treatments in each series potassium sulphide, 1 oz. to 2 gals. water.

Note. There were six check rows, numbers 6, 11, 12, 22, 27 and 28.
effective. During the few days previous to this date the disease appeared on the young leaves; and in the amount of mildew on the foliage there seemed to be no difference between the treated and untreated bushes. The fruit on the untreated bushes was very badly mildewed. The treatments with lysol and formalin in some instances seemed to have slightly checked the mildew on the fruit. The combined treatment of Bordeaux mixture and potassium sulphide had checked the disease but the most favorable results appeared where the potassium sulphide had been used for very early and medium early treatments.

PICKING THE FRUIT.

The last spraying was made June 21. Messrs. King & Robinson wished to market the fruit green, so on July 6 and 7 it was picked. The mildewed fruit and perfect fruit were weighed separately for each different treatment. In order to have an accurate basis of comparison the yields are figured so as to give the average per plant in each experiment. The results are so arranged in the following table that the reader can easily compare the same remedies in the different series. It must be borne in mind that Series I received seven sprayings beginning April 12, Series II received six sprayings beginning April 23, and Series III received five sprayings beginning May 5.
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Average yield per bush.</td>
<td>Average yield per bush.</td>
<td>Average yield per bush.</td>
</tr>
<tr>
<td>Bordeaux mixture: *</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1 to 11 formula...</td>
<td>26.2 15.7 37.4</td>
<td>34.8 14.3 29.1</td>
<td>18.1 25 58</td>
</tr>
<tr>
<td>Potassium sulphide:</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1 oz. to 3 gals. water</td>
<td>76.8 5 4</td>
<td>45.3 12.6 84.7</td>
<td>22 28 56</td>
</tr>
<tr>
<td>1 oz. to 2 gals. water</td>
<td>56.2 4 6.6</td>
<td>42.6 6 12.3</td>
<td>38.5 5 11.5</td>
</tr>
<tr>
<td>Formalin:</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1 oz. to 1 gal. water</td>
<td>21 20 48.8</td>
<td>3.5 12.6 78.3</td>
<td>22 28 56</td>
</tr>
<tr>
<td>1 oz. to 2 gals. water</td>
<td>17 24.5 59.1</td>
<td>9 50 84.7</td>
<td>10 25 71.4</td>
</tr>
<tr>
<td>1 oz. to 4 gals. water</td>
<td>28.4 31.5 52.6</td>
<td>21 39 65</td>
<td>17.6 41.8 70.4</td>
</tr>
<tr>
<td>Checks:</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>19.4 26.5 57.7</td>
<td>9 33.2 78.7</td>
<td>9 33.2 78.7</td>
</tr>
<tr>
<td>Lysol:</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1 oz. to 1 gal. water</td>
<td>37 12 24.5</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1 oz. to 2 gals. water</td>
<td>19 25 56.8</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1 oz. to 4 gals. water</td>
<td>44 26 37.1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Check:</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>19.4 26.5 57.7</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*Last three treatments in each series potassium sulphide, 1 oz. to 2 gals. water.

From a study of Table II we see that, with the exception of Bordeaux mixture, the very early treatments gave the best results. Where the treatment with potassium sulphide, 1 oz. to 3 gals. water, was begun very early only 5 per cent of the fruit mildewed. Where it was begun medium early there was three times as much mildewed fruit, while in the treatment begun late there was a little more than two and one-half times as much. The bushes treated very early with potassium sulphide, 1 oz. to 2 gals. water, yielded 6.6 per cent of mildewed fruit and those where the treatments was begun medium early and late gave nearly twice as much.
Lysol ranks next to potassium sulphide in effectiveness. It was used in Series I only and the bushes treated with 1 oz. to 1 gal. water gave 24.5 per cent of mildewed fruit; bushes treated with the weaker strengths gave 56.8 per cent and 37.1 per cent respectively of mildewed fruit.

The best result with Bordeaux mixture was where the sprayings were begun medium early and 29.1 per cent of the fruit mildewed. With the very early treatment 37.4 per cent of the fruit mildewed and where spraying was begun late 58 per cent of the fruit mildewed.

Formalin seemed to have little if any effect in checking the mildew. The bushes in Series I treated with 1 oz. to 1 gal. of water gave 48.8 per cent of mildewed fruit. The amount of mildewed fruit in the other experiments with formalin varied from 52.6 per cent to 78.3 per cent while the largest amount from the untreated bushes was 78.7 per cent.

The average cost of the various fungicides is given in the table below.

### Table III. Average Cost of Fungicides.

<table>
<thead>
<tr>
<th>Fungicide</th>
<th>Per pound</th>
<th>For 1 gallon of solution</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>1 oz. to 1 gallon water.</td>
</tr>
<tr>
<td>Lysol</td>
<td>65</td>
<td>4.06</td>
</tr>
<tr>
<td>Formalin</td>
<td>59</td>
<td>3.125</td>
</tr>
<tr>
<td>Potassium sulphide</td>
<td>18</td>
<td>—</td>
</tr>
<tr>
<td>Bordeaux mixture</td>
<td>—</td>
<td>—</td>
</tr>
</tbody>
</table>

By formalin as used in this article is meant the 40 per cent solution of formaldehyde gas. When purchasing, it is well to ask for the 40 per cent solution of formaldehyde gas as it is quoted much lower than the same material under the name of formalin.*

RECOMMENDATION.

For holding the gooseberry mildew in check the Station recommends potassium sulphide as the most effective remedy. It may be applied at the rate of 1 oz. to 2 or 3 gals. of water beginning very early in the season, just as the buds are breaking, and repeating about every ten days, depending, of course, upon the condition of the weather.

GENERAL APPEARANCE OF MILDEW.

The mildew is a parasitic plant, or fungus, which appears on the surface of the fruit and young shoots. When first noticed it is composed of glistening, white threads which give it a frost-like appearance. As the fungus develops the threads become more numerous and matted, lose their glistening color and finally become a mass of brownish felt-like substance. It has now completed its growth and ripened its winter spores and can usually be peeled off the berries without rupturing the skin.

If the attack is severe the tender young leaves and shoots will be seriously injured, if not killed, and the growth checked. The growth of the berries will also be checked and they are likely to be misshapen and even to crack open thus letting in the germs of decay.

The spores by which the fungus is reproduced correspond to the seeds in higher plants but are very much simpler in construction. There are two kinds of spores, the summer spores and the winter spores. The summer spores (conidia) are formed on vertical branches of the glistening white threads which make up the fungus. As the vertical branch grows in length a partition appears near the upper end. This partition soon cuts off all connection with the lower part of the branch and the upper part develops into a spore. While this spore is developing at the tip the branch is growing longer and the formation of new spores is begun in the same way lower down. As soon as the tip spore ripens it drops off and as the branch is continually growing and forming new spores, there is a succession of ripe spores scattered
broadcast to spread the disease. When these spores alight on the leaves or fruit with proper conditions of moisture and temperature present, growth immediately takes place; and since thousands of these spores are formed daily the disease is spread very rapidly.

The fertilization and development of the winter spores correspond to the fertilization and development of seeds of higher plants but are quite different and usually take place late in the season of growth of the fungus. In certain instances where two threads come near to or cross each other an enlargement or cell forms on each, one partaking of the functions of the male organs and the other of the female organs of a flower. At a certain stage of the development protoplasm passes from the male cell to the female cell and the latter is thus fertilized. Growth immediately begins and by the time the fungus assumes a brownish color black specks may be seen upon it; these specks are the winter spore cases (perithecia). Within the dark covering of the winter spore case will be found an inner spore case (ascus) which contains eight of the winter spores. In this double covering of spore cases the winter spores live over winter. By spring the cases break open and the spores escape. They are blown about by the wind and when they reach the leaves or fruit of the gooseberry bush under favorable conditions growth takes place and the pest is started for the season.

As a rule only the English varieties and their seedlings are attacked by mildew although the American varieties are not always exempt. A comparison of the susceptibility to mildew of the English varieties as grown at this Station is given in Bulletin No. 114.