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Antonios George Plakidas

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CONTROL OF STRAWBERRY LEAF BLIGHTS IN LOUISIANA

by

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CONTROL OF STRAWBERRY LEAF BLIGHTS IN LOUISIANA

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INTRODUCTION

STRAWBERRY GROWING is one of the leading agricultural industries in Louisiana. The center of the strawberry section is in Tangipahoa parish, with smaller, but gradually increasing, acreages in the neighboring parishes of Washington, St. Tammany, St. Helena, Livingston, Ascension, and East Baton Rouge. The average acreage for the last five years (1926-1930) was 22,352 acres with an average yield of 102 crates per acre and an average value of 6,472,800 dollars.

The following table shows the total acreage, the carloads shipped, the average yield per acre, and the total value of the crop for each of the past six years, 1926-1931. The banner year 1931 is included in the table, although some of the figures for that year are not final.

<table>
<thead>
<tr>
<th>Year</th>
<th>1926</th>
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<tr>
<td>Yield per acre (in 24 pint crates)</td>
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<td>66</td>
<td>119</td>
<td>117</td>
<td>96</td>
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<td>Total value of crop</td>
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<td>$3,843,576</td>
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<td>$7,161,840</td>
<td>$6,506,700</td>
<td>$9,000,000†</td>
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*Final official figures of yield per acre are not available. Judging from the number of carloads shipped, (which does not include the cold pack and the local sales), the yield per acre would be nearly twice that of 1930.

†Figures obtained from local sources place the total value (including the cold pack and the local sales) at $9,700,000.
The main factor responsible for the yearly differences in yield per acre are weather conditions, length of picking season, and diseases and insect pests. Weather conditions affect the yield not only by directly influencing the growth of the plants but also indirectly by being favorable or unfavorable for the development and spread of insect pests and diseases. The strawberry is subject to many diseases—various leaf blights, dwarf, crown rot, root decay, root knot, and several berry rots—which frequently decrease the crop to a considerable extent. Accurate statistics as to the extent of the losses caused by diseases are not available, but these are much higher than commonly realized. It is probably a conservative estimate to state that diseases cut down the crop by 25-35%. This reduction is enough to turn an expected profit into loss.

The Plant Pathology Department of the Louisiana Agricultural Experiment Station has been carrying on investigations on strawberry diseases during the last four years. A circular on diseases and insect pests, which is still available, was published in 1928. The most serious diseases of the strawberry in Louisiana seem to be the two leaf blights—the leaf spot ("rust," "bird's eye spot") and the scorch.

**LEAF BLIGHTS, NATURE AND SYMPTOMS**

1. Leaf Spot (*Mycosphaerella fragariae*)

   The leaf-spot ("rust," "bird's eye spot") disease is caused by a fungous parasite, which enters the leaf and kills some of the leaf tissues. When the spots first appear, they are small and purplish, but gradually increase in size and become lighter in color. The fully developed spot has a grayish to white center with a reddish border, and is about an eighth of an inch in diameter. In cases of severe infection, the spots are so numerous that they cover the greater part of the leaf area (Fig. 1) and often cause the leaf to die. The plant is thus defoliated, becomes weak and unproductive, and in extreme cases may die. Even when the injury is not so severe, the disease causes a loss. There
is a decrease in yield, resulting from the weakened condition of the plant.

2. Scorch (*Diplocarpon earliana*)

The scorch is another leaf disease which is about as prevalent and as destructive as the leaf-spot, and is often not distinguished from the latter by the growers.

In Louisiana, the two diseases usually occur together, though one or the other may be more prevalent in certain fields or in certain sections.
The scorch makes its appearance first as minute reddish to purplish spots on the upper surface of the leaf. These spots enlarge rather rapidly, forming irregular purplish blotches (Fig. 2). When the infection is general, these blotches coalesce, and the entire leaf surface becomes purplish to reddish. The margins of the leaves then dry up as if scorched by fire. The disease also occurs on the leaf petioles and on the flower stems as elongated, purplish, sunken areas. The flower stems are often girdled, and this results in the death of the flowers and young fruit.

**DEVELOPMENT OF LEAF BLIGHT DISEASES**

Although the two leaf blight diseases are caused by separate and distinct parasites, the life cycles of these are similar. If the surface of a "rust" spot is scraped and this material is examined under the microscope, thousands of microscopic spores are seen. (Fig. 3). These spores are the organs of reproduction of the parasite. They may be likened to the seed of weeds. As weed seed are blown about by the wind and germinate when they fall in places where moisture and other conditions are favorable, so these

**Fig. 3.** A. Spores of the Leaf Spot fungus, *Mycosphaerella fragariae.*
B. Spores of the Scorch fungus, *Diplocarpon earliana.*
spores are carried about by the wind and rain (and probably by insects) and fall on the leaves. If conditions are favorable, especially if there is moisture present, the spores falling on the leaves germinate and the germs penetrate into the tissue where they grow and mature, killing the invaded tissue, thus producing the spots. When mature, new spores are produced on the surface of the spots, and the cycle is repeated. It is important to keep this life cycle in mind, for control of these diseases is based on a knowledge of the habits of the parasites causing them. When spores fall on unsprayed leaves they germinate and enter the tissue. But if the leaves have been sprayed, the spores falling on them will be killed by the spray material and no infection will take place.

In more northern regions, in addition to the spores already described, these parasites produce a crop of winter spores in the fall. These spores drop to the ground with the dead leaves and thus carry the parasites over the winter. In Louisiana, this type of spore has never been found and is therefore of no economic importance. In Louisiana where strawberries continue to grow during the winter, the parasites overwinter on the living leaves.

**TEMPERATURE RELATIONS OF THE PARASITES**

Both the leaf spot and the scorch parasites have a wide range of temperature in which they can grow and produce infection. Tests made in the laboratory with pure cultures of these organisms showed that they can grow in temperatures ranging from 32° F to 85° F. However, there is a difference in their temperature preference. The leaf spot organism made its best growth at temperatures of 65°-72° F, a fair growth from 45°-63° F, and poor growth from 32°-45° F and from 73°-81° F. The scorch parasite, on the other hand, made practically no growth at all below 45° F, grew best at 72°-80° F, and made a fair growth at 80°-88° F. It is seen that the scorch organism has an optimum temperature about 10° F higher than that of the leaf-spot organism.
The results of artificial infection tests were substantially in agreement with those of the temperature tests. By inoculating plants with the spores of the two parasites in different seasons of the year, results were obtained which agree, in general, both with the results of the temperature tests and with the behavior of these organisms in the field. With the leaf spot organism (*M. fragariae*), heavy infection was obtained on the inoculated plants from November to May, and light infection from June on. With the scorch (*D. earliana*), on the other hand, the reverse was true. Heavy infection was obtained from May to November, and very light infection during the cooler months.

It is a common belief among the growers that a freezing spell brings out the "rust." This phenomenon is possibly more apparent than real. The cold checks the growth of the plants and makes them appear more "rusty", while during warm spells the plants grow faster and, for a time at least, appear to outgrow infection. But the fact remains that under Louisiana conditions, the leaf spot ("rust") parasite can be very active under the prevailing winter conditions and often infects the new leaves just as fast as they unfold. The scorch parasite, on the other hand, is less active during the winter and more active during the warm months of spring and summer.

**RESULTS OF THE SPRAYING EXPERIMENTS**

The leaf blights have been successfully controlled in other states by spraying with Bordeaux Mixture. In Louisiana definite information on this matter has been lacking. Some growers reported that they had obtained excellent results from spraying, while others claimed that spraying had no effect. In order to have definite information on this subject, spraying experiments have been conducted in the field during the past four years. These experiments have given satisfactory and clear-cut results and leave no uncertainty regarding the efficacy of spraying for the control of these diseases.
1. The 1928 Spraying Experiments. In 1928 a spraying experiment was conducted on Mr. W. E. Dyson's place near Amite. The experiment was of a preliminary nature and had as its purpose, (1) to determine if Bordeaux is effective for the control of the leaf blights, and (2) to find out when is the best time to spray. The field was divided into 5 plats of approximately ¼ of an acre each. In one plat, the tops of the plants were dipped in Bordeaux at the time of planting, with no subsequent treatment. The plants of plat No. 2 were sprayed with 4-4-50 Bordeaux twice, on December 23 and 31, those of plat No. 3 were sprayed six times (December 23, January 4, 16, and 28, February 8 and 20). The plants in plat No. 4 were also sprayed six times, but the spraying was begun later. These were sprayed on January 4, 16, 28, February 8, 20, and March 13. The plants in plat No. 5 were left unsprayed as check.

Results: All three sprayed plats (Nos. 2, 3, and 4) remained practically free of infection until the middle of May when the last observations were made. The dipped plants (plat No. 1) showed a light amount of spotting and those of the unsprayed check (plat No. 5) a moderate amount. These spots were chiefly those of scorch. The leaf-spot proper ("rust") was present only to a small degree.

On the whole, this experiment was not very successful. While the sprayed plants remained practically free from infection, there was such a small amount of disease in the field, even on the unsprayed plants, that no definite conclusions could be drawn. For reasons which are not as yet understood, the leaf-spot disease ("rust") is generally not so severe in the northern part of Tangipahoa parish as in the southern portion (south of Hammond). In all of the later tests, the spraying was done in fields where it was known that both leaf blights were present in severe form.

2. The 1929 Spraying Experiment. In 1929, the spraying test was conducted on Mr. Andrew Polgar's place near Hammond. Both leaf-spot and scorch infections were very
severe in this field the previous two years. The plan of the experiment was as follows:

Plat I. Five rows (about $\frac{1}{4}$ of an acre), sprayed three times, every ten days (January 8, and 18, and February 1).

Plat II. Five rows (about $\frac{1}{4}$ of an acre), left unsprayed as check.

Plat III. Five rows (about $\frac{1}{4}$ of an acre), sprayed six times (January 8 and 18, February 1, 11, and 23, and March 7).

Plat IV. Five rows (about $\frac{1}{4}$ of an acre), sprayed the same number of times and on the same dates as Plat III, but small amounts of liquid ammonia were added to the Bordeaux spray. For the first two sprayings one pint of ammonia was added to 50 gallons of spray, but this was increased to one quart per 50 gallons of spray for the rest of the sprayings.

Duplicate plats for each treatment were located in another part of the field, so that for each treatment the total area was about $\frac{1}{2}$ acre, which is large enough for the results to be dependable.

Results: In spite of the fact that the season was very wet so that much of the spray was washed away by the rains soon after it was applied, the results obtained were very striking and very satisfactory. The plants of the two unsprayed check plats were very severely spotted, some becoming almost completely defoliated and dying by the first part of May.

The plants sprayed three times (January 8, 18, and February 1) were decidedly less spotted than the unsprayed ones, but still they showed a relatively severe amount of infection.

The plants sprayed six times, both with and without the addition of ammonia to the spray remained practically free from infection, and, on the average, were about twice as large as the unsprayed ones. It is possible that spraying in addition to controlling the diseases, has a stimulating influence on the growth of the plants. The larger size of the sprayed plants cannot altogether be attributed to their
being free from disease, for the difference in size between
the sprayed and unsprayed plants becomes apparent before
the disease has progressed far enough to do real damage
to the unsprayed ones. This stimulation in growth by
spraying was also observed in the experiment of the previ­
ous year in Amite where the disease was light, and has
been noticed in the spraying tests of the past two years.
That spraying with Bordeaux has a stimulating effect other
than that brought about by controlling diseases has been
observed by many other investigators on different kinds of
plants, but the question of what is the actual cause of the
stimulation has not been definitely settled.

The addition of ammonia to the spray had no apparent
beneficial or harmful effects. Spray containing ammonia
was no more effective in controlling the leaf spots than
spray without the ammonia. Neither did ammonia have
any stimulating effect on the growth of the plants.

Summing up, this experiment has shown that:

1. Six sprayings with 4-4-50 Bordeaux at about 10-
day intervals from January 8 to March 7, gave almost com­
plete control.
2. Three sprayings (January 8, 18, and February 1)
gave only partial control, showing that three sprayings are
not sufficient.
3. Spraying seemed to have a stimulating effect on
the growth of the plants other than that brought about by
the control of the diseases.
4. Ammonia had no effect either harmful or bene­
ficial.

3. The 1930 Spraying Experiment. In 1930, spraying
test was again conducted on Mr. Andrew Polgar’s place
near Hammond. Arrangements were made for keeping
a record of the yields in order to determine if there was
any difference in yield between the sprayed and unsprayed
plats and thus to determine the value of spraying from the
economic standpoint. In order to facilitate the taking of
yield records the plan of the experiment was made as sim­
ple as possible. One plat (12 rows, approximately 2/3 of
Fig. 4. Comparison of the size and number of berries per pint basket from sprayed and unsprayed plots. One pint from the sprayed plat contained 46 berries, each berry averaging 7.26 grams in weight. From the unsprayed plat, it took 78 berries to make one pint, with an average weight per berry of 3.54 grams. 2/7 natural size.

an acre) was sprayed with 4-4-50 Bordeaux seven times (January 6, 17, 27, February 5, 17, 27, and March 10) and another plat of equal size was left unsprayed as check. No ammonia was used in the spray.

Results: Very sharp and clear-cut results were obtained. The sprayed plants remained healthy, with practically no spots (a small amount of spotting developed toward the end of the picking season), while the unsprayed plants were very badly spotted, some of them shedding most of their leaves and some being completely killed. The sprayed plants were again, on the average, twice as large as the unsprayed ones. Naturally, the berries of the unsprayed plants were small and many were culls. The dif-
ference in the size of berries from the sprayed and unsprayed plants is shown in Figure 4. A pint from the unsprayed plants picked at random from a carrier as it was brought to the packing shed, was found to contain 78 berries, averaging 3.54 grams per berry; a pint from the sprayed plants, similarly picked, contained only 46 berries, averaging 7.26 grams per berry. It is seen that it took nearly twice as many berries from the unsprayed plants to make a pint.

The total yield from the sprayed 2/3 acre plat was 183 crates and that from the unsprayed 111 1/2 crates, or a difference of 71 1/2 crates in favor of the sprayed. On a one acre basis, the difference was 107 1/4 crates. The average price of berries per crate for the 1930 season was $2.50. Therefore,

107 1/4 crates @ $2.50 per crate..................$268.12

Deduct: Value of empty crates.................$30.00
Cost of picking and packing.... 58.00
Cost of spraying
(Materials and labor)......... 22.00

Total ..................................$111.00

Net profit per acre...................$158.12

The cost of spraying, $22.00 for materials and labor, has been figured higher than would ordinarily be (the labor was figured at 25 cents per hour). The fact is that the smaller the field sprayed, the higher the cost per acre. It takes about as much time to mix two hundred gallons of spray as to mix fifty.

4. The 1931 Spraying Experiment. In 1931, the spraying test was located on Mr. J. N. Walz's place, south of Hammond. The place was selected both on account of the willingness of the owner to cooperate and from the fact that both the leaf-spot and the scorch were known to occur in abundance.
Ten rows (1/3 of an acre) were sprayed 8 times at about 10-day intervals (January 2, 14, 22, February 3, 13, 25, and March 6 and 13) and 10 rows of equal size were left unsprayed as check. Bordeaux spray 4-4-50 was used.

Results: The results obtained were very similar to those of the preceding year, but because of the long picking season and the much larger crop, the difference in yields between the sprayed and unsprayed was proportionally larger. The difference in yield between the sprayed and unsprayed was relatively small at the beginning of the picking season, but increased steadily as the season advanced and the ravage of the disease on the unsprayed plants became greater. Thus, from March 28, when the picking started, to April 15 the yield of the sprayed plants was 1.4 times that of the unsprayed. This figure became 1.9 for the next two weeks, and 2.3 from May 1-15. After that date, no berries were picked from the unsprayed plants. The plants had become so badly defoliated and the berries so small and worthless that the pickers refused to pick them and the packers refused to pack them (Fig. 5). In the sprayed patch, berries were picked until May 27, which was the end of the picking season. The final yields were as follows:
Sprayed ..................... 116 crates
Unsprayed ..................... 43 crates

Difference in favor of sprayed... 73 crates

The experimental patch was only 1/3 of an acre in size, so the difference in yield per acre was 219 crates, which at the rate of $2.03 per crate (the average price for the season) amounted to $444.57.

From this amount must be deducted the following:

1. Cost of spraying, materials and labor.....*$ 9.26
2. Cost of empty crates (@ 22c per crate)... 48.18
3. Cost of picking (@ 23c per crate)...... 50.37
4. Cost of packing (@ 10c per crate)...... 21.90

Total .................................. $129.71

This leaves a net profit of $314.86 per acre.

*This figure is perhaps high. It is based on 40 gallons of spray and 4 hours of labor per acre for each spraying. The cost of labor is figured at 20c per hour, which is higher than the average paid farm laborers in that section.

It is realized, of course, that this was an abnormal year. Because of the long season and favorable weather conditions, the crop was unusually large and the reduction in yield due to leaf blights proportionately large. Yet, although the yield in this field (348 crates per acre) is considerably larger than the average yield of the entire section for the year (estimated 180 crates per acre), yields of 350, 400 and even 500 crates per acre are not uncommon even in an average year.

It is not claimed that increases in yield of this magnitude will be obtained by spraying in every case and in every season. Still, the results of both this and last year's experiments show that spraying is economically profitable. The cost of spraying is relatively insignificant compared to the marked increases in yield obtained.
PREPARATION OF BORDEAUX SPRAY

Making Bordeaux mixture for spraying is relatively easy, and yet certain care is necessary in its preparation. To prepare the standard 4-4-50 Bordeaux mixture (four lbs. of bluestone, four lbs. of unslaked lime, and fifty gallons of water) the following method will be found satisfactory:

To make 50 gallons of spray, dissolve four pounds of bluestone in 25 gallons of water in a wooden barrel; slake four pounds of rock lime in a separate barrel, and when the lime is completely slaked, add enough water to bring the lime solution to 25 gallons; then mix bluestone and the lime solutions in a third barrel, stirring thoroughly. The spray mixture is now ready to use.

If it is desired to make less than 50 gallons of the spray mixture, use the different materials in corresponding smaller proportions. For example, to make 25 gallons of the spray mixture, dissolve two pounds of bluestone and two pounds of lime in 12½ gallons of water each.

Bluestone dissolves slowly if placed at the bottom of the container, but it dissolves rather fast if it is placed in a sack and suspended near the top of the water. It should be kept from contact with metals, as it will be chemically changed. The container will be corroded and the solution ruined.

The bluestone and the lime solutions will keep practically unchanged for a long period if kept separately. After the two are mixed, however, the mixture should be used the same day, or at least not later than the second day, for it loses its adhesiveness and effectiveness on standing.

Rock (unslaked) lime should be used in preference to hydrated lime, for it makes a finer spray which adheres well to the surface of the leaves. This form of lime, however, is not only hard to get (unless bought by the whole barrel) but also hard to keep, for unless kept hermetically sealed it will airslake. Hydrated lime, on the other hand, is easy to get and easily handled and kept. Several growers have used hydrated lime in their spraying with satisfactory re-
sults. So if rock lime is not easily obtainable, hydrated lime may be used in its place. It is recommended to use five pounds instead of four when using the hydrated lime.

WHEN AND HOW MANY TIMES TO SPRAY

As to the time for spraying and the number of applications, it is not easy to give definite directions because conditions vary from year to year, and also from field to field. On the whole, effective control of the leaf blights should be obtained by spraying with Bordeaux every ten days, beginning the first week in January and continuing until the first week in March. This will mean six to eight applications. In fields where the leaf spot is not very prevalent, fewer sprayings (perhaps four to five applications) will be sufficient. This is true for most fields in the northern portion of Tangipahoa Parish. The reasons why the leaf-spot ("rust") is less severe in the northern part of the parish are not well understood, but it is a common observation among the growers that plants taken from the northern part of the parish and planted south of Hammond will be less affected with leaf-spot than the local plants during the first year. On the other hand, plants from the southern part of the parish when planted in the northern part, are more severely spotted the first year than the local plants. After the first year, there is no difference in the degree of infection between the progenies of the local and imported plants.

In any case, it is well to remember that spraying is a preventive measure. It should be used as a protection to prevent the parasites from infecting the plants. Once the plant becomes badly infected, spraying will not cure it, though it may check the spread of the disease to the new leaves and thus allow the plant to make a partial recovery. But it is unwise to wait until the disease has done considerable damage before attempting to control it. The cost of spraying, compared to the large increases in yield obtained, is insignificant. It is possible that in certain years conditions may be so unfavorable for the spread of the diseases that spraying will not pay. However, strawberry
growing is such an expensive type of farming that the grower cannot very well afford to take chances. All growers should spray as a matter of insurance.

**DOES SPRAYING INJURE THE OPEN BLOSSOM?**

The effect of the spray solution on open flowers is a question of considerable importance. Growers often state that they are afraid to spray after the blossoms open lest they do more harm than good. To answer this important question the following tests were made:

1. On March 12, 1930, in Baton Rouge, the plants of one-half row were sprayed and the other half left unsprayed. Fifty-four young open flowers in the sprayed part of the row, and an equal number in the unsprayed, were labeled to be examined later, in order to see what effect the spray would have on the setting of fruit. The labeled flowers were examined ten days later with the following results:

   **Sprayed:** 50 out of 54 set fruit, or 92.6%.
   **Unsprayed:** 52 out of 54 set fruit, or 96.3%.

   Or a difference of 3.7% in favor of the unsprayed.

2. The test was repeated in Hammond on March 13, 1931, using a larger number of blossoms. The following results were obtained:

   **Sprayed:** 198 out of 250 set fruit, or 81.6%.
   **Unsprayed:** 191 out of 250 set fruit, or 79.0%.

   Or a difference of 2.6% in favor of the sprayed.

Although the number of blossoms counted was not perhaps sufficiently large, the results of these two tests would indicate that spraying does not injure the blossoms and does not interfere with pollination, at least not sufficiently to affect the yield.
OTHER CONTROL PRACTICES

In addition to the winter spraying, other control measures for the leaf blight diseases may be suggested:

1. *Summer Spraying*: In growing the summer plants, it is probably advisable to keep them sprayed regularly until they are ready to be set in the field in the fall. This can be done with very little cost, for the acreage of summer plants is very small. The leaf-spot ("rust") does not spread very much during the hot summer months, but still it persists and it is there to start heavy infection as soon as the weather cools off. The scorch, on the other hand, is likely to become serious during the summer and to weaken the plants considerably. Summer spraying has two advantages: (1) By checking the diseases, it aids in developing healthy and vigorous plants for fall planting. (2) By starting the fall planting with clean plants, the source of infection is eliminated to a large extent, and thus a considerable time will elapse before leaf diseases begin to show again.

2. *Sanitary measures*: Good cultural practices should do a great deal toward keeping leaf (and other) diseases in check. The land should be well drained. It is a common observation that leaf spots are worse in low areas in the field where water stands in the middles for some time after rains. The field should be kept free from weeds. Where the plants are shaded by weeds, the foliage remains wet for a considerable time after a rain, and the spores of the parasites which produce the leaf diseases falling on the moisture-laden leaves, find very suitable conditions for germination.

3. *Dipping*: If the summer plants have not been sprayed, it may be advisable to dip the tops in 4-4-50 Bordeaux at the time of planting in the fall. The outer, spotted leaves should be removed and the tops of the plants dipped. This can be done without much difficulty and at very small cost. About two gallons of Bordeaux Mixture in a wooden bucket is enough. The plants may be dipped in bunches of convenient size, for just a few seconds—long enough to
get the young leaves and crowns wet with the spray mixture—and then set out. Dipping will kill any spores which may be on the surface of the young leaves and thus prevent early infection.

**SUMMARY**

This paper is mainly concerned with the results of four years spraying experiments for the control of strawberry leaf blights (leaf-spot and scorch), but other information is given and other matters are discussed, such as descriptions of the two diseases, temperature relations and life cycles of the parasites, directions for making Bordeaux Mixture, recommendations as to time of spraying, and suggestions for the use of sanitary measures other than spraying.

Spraying with 4-4-50 Bordeaux every ten days from the first week in January to the first week in March gave almost complete control. Three sprayings (January 8 to February 1) gave only partial control.

Yield data were secured only during the years 1930 and 1931. Marked differences in yields between the sprayed and the unsprayed plats were obtained in both cases. In 1930, the sprayed plat (approximately 2/3 of an acre) yielded 183 crates and the unsprayed check plat of the same size only 111.5, or a difference of 71.5 crates in favor of the sprayed. In 1931, the difference was still greater. The sprayed plat (1/3 of an acre) yielded 116 crates, and the unsprayed check of the same size 43 crates, or a difference of 73 crates in favor of the sprayed.

Spraying, in addition to controlling the leaf blights, appeared to have a stimulating effect on the growth of the plants.

The addition of ammonia to the spray mixture (from one pint to one quart per 50 gallons of the spray, as practiced by some growers) was found to have no noticeable effect either in getting better control of the diseases or in stimulating plant growth.
Bordeaux was found not to be injurious to open blossoms or to interfere with pollination.

Pure cultures of *Mycosphaerella fragariae* and *Diplocarpon earliana* were used in studying the temperature range of these parasites. Both organisms can grow at relatively wide ranges of temperature, but the scorch organism, (*D. earliana*), has an optimum temperature about 10° F. higher than the leaf-spot organism, (*M. fragariae*). The latter made its best growth at 63°-72° F., a fair growth from 45°-63° F, and poor growth from 32°-45° F and from 73°-81° F. The leaf scorch organism made practically no growth below 45° F., grew best at 62°-70° F., and made a fair growth from 80°-88° F.

In making inoculations with pure cultures of these organisms at different seasons of the year, heavy infections were obtained with *M. fragariae* from November to May and light infections from June to November. With *D. earliana* heavy infections were obtained from May to November, and very light infections during the cooler months.