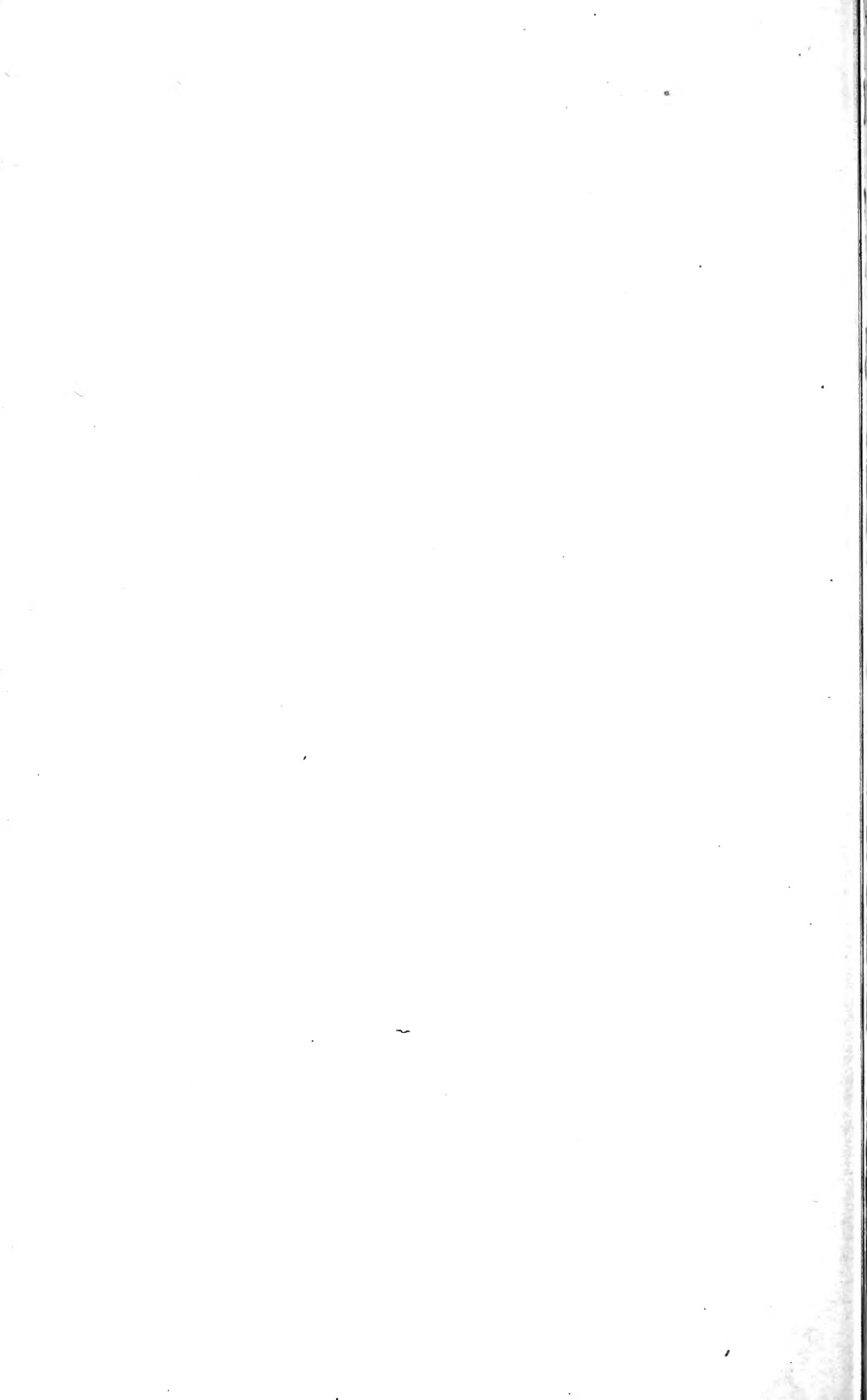


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THE SUBSTITUTION OF LIME-SULPHUR PREPARA-  
TIONS FOR BORDEAUX MIXTURE IN THE  
TREATMENT OF APPLE DISEASES.

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BY

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PATHOLOGIST IN CHARGE OF ORCHARD-SPRAYING  
EXPERIMENTS AND DEMONSTRATIONS,  
FRUIT-DISEASE INVESTIGATIONS.

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**BUREAU OF PLANT INDUSTRY.**

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[Cir. 54]

## THE SUBSTITUTION OF LIME-SULPHUR PREPARATIONS FOR BORDEAUX MIXTURE IN THE TREATMENT OF APPLE DISEASES.<sup>a</sup>

### INTRODUCTION.

In recent years Bordeaux mixture has come into ill favor among the apple growers on account of its injurious effect upon the fruit and foliage of certain varieties, and there is a growing demand for a reliable fungicide which can be used for the control of apple diseases without producing such injury. Bordeaux mixture is undoubtedly the best all-around fungicide known, and it is unfortunate that the apple growers have to consider the possibility of giving it up; but the russetting of the fruit and the burning of the foliage caused by it are so objectionable that it seems highly desirable, if not necessary, to adopt a less injurious fungicide even at the risk of a partial sacrifice of efficiency in the control of diseases. The subject of Bordeaux injury has recently been admirably discussed by Prof. U. P. Hedrick,<sup>b</sup> of New York, and by Prof. C. S. Crandall,<sup>c</sup> of Illinois, and will be considered only incidentally in this paper.

During the past three years the writer has been working on the problem of securing a satisfactory substitute for Bordeaux mixture and not without some success. The self-boiled lime-sulphur wash which was developed primarily for spraying peach trees has been found to be an excellent spray for the control of mild cases of apple diseases and to be entirely harmless to fruit and foliage. The concentrated lime-sulphur solutions, both commercial and home prepared, when diluted to contain about 4 pounds of sulphur to 50 gal-

<sup>a</sup> Acknowledgment is hereby made of the hearty cooperation and assistance given the writer of this paper in his investigations by the Strathmore Orchard Company, of Mount Jackson, Va., and the Elm Springs Orchard Company, of Fishersville, Va., and also by Messrs. M. F. Gilkerson, of Staunton, Va., and W. S. Ballard, of Crozet, Va., in whose orchards the experiments and demonstrations were conducted.—G. H. POWELL, *Acting Chief of Bureau.*

<sup>b</sup> Bulletin 287, New York (Geneva) Agricultural Experiment Station. 1908.

<sup>c</sup> Bulletin 135, Illinois Agricultural Experiment Station. 1909.

lons of water have proved to be about as effective in the control of apple scab and leaf-spot as Bordeaux mixture and to be much less injurious.

Prof. A. B. Cordley,<sup>a</sup> in 1908, seems to have been the first to point out the possibility of dilute lime-sulphur solutions as a substitute for Bordeaux mixture in the treatment of apple diseases, especially scab. In an address before the 1907 meeting of the American Pomological Society, the writer<sup>b</sup> gave results of experiments which he conducted in Arkansas, showing that a self-boiled lime-sulphur mixture might be expected at least partially to control bitter-rot and scab. Again in the *Western Fruit Grower* of January, 1909 (pp. 5-6), the writer showed that the commercial lime-sulphur solution registering 32 degrees on the Baumé scale, when used at a strength of 1 gallon to 25 gallons of water, would control apple scab on the Winesap about as well as Bordeaux mixture without materially injuring the fruit or foliage. In the same issue of the paper just mentioned (pp. 6-7), Prof. R. Kent Beattie reported the satisfactory control of apple scab by very much stronger solutions of the commercial lime-sulphur—1 to 11, 1 to 14, and 1 to 17—and he reported no injury whatever to foliage or fruit.

In 1908 the writer<sup>c</sup> controlled the cherry leaf-spot in Illinois with the commercial lime-sulphur solution, 1 gallon to 40 gallons of water, and with the self-boiled lime-sulphur, as well as with Bordeaux mixture. During the same year experiments with the lime-sulphur solution for apple scab, conducted by the writer<sup>d</sup> in Nebraska and Arkansas, gave good results, and similar experiments conducted in New Hampshire during the same year by Dr. Charles Brooks<sup>e</sup> in cooperation with the writer showed the commercial solution to be almost as effective against apple scab as Bordeaux mixture.

Mr. Errett Wallace<sup>f</sup> reports that in experiments which he conducted in New York during 1909 the commercial lime-sulphur solution at a strength of 1 gallon to 30 gallons of water did not injure fruit or foliage and was as effective in controlling apple scab as Bordeaux mixture, although the disease was not serious in the orchard treated. Although none of the experiments referred to above were exhaustive, the evidence thus far points to the lime-sulphur solution as a valuable substitute for Bordeaux mixture, at least in the treatment of apple scab.

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<sup>a</sup> *Rural New Yorker*, March 7, 1908, p. 202.

<sup>b</sup> *Proceedings, American Pomological Society*, 1907, pp. 39-45.

<sup>c</sup> *Cir. 27, Bureau of Plant Industry, U. S. Dept. of Agriculture*, 1909, pp. 12-15.

<sup>d</sup> *Cir. 27, Bureau of Plant Industry, U. S. Dept. of Agriculture*, 1909, pp. 15-17.

<sup>e</sup> 19th and 20th Annual Reports, *New Hampshire Agricultural Experiment Station*, pp. 385-389.

<sup>f</sup> *Western Fruit Grower*, January, 1910, pp. 24-25.



Experiments conducted by the Bureau of Plant Industry during 1909 give further evidence of the value of the lime-sulphur sprays as fungicides for summer use. These experiments cover a wide range of conditions, having been conducted in Virginia, Michigan, and Arkansas. Eleven varieties were treated. Four different brands of the commercial lime-sulphur solution and a similar home-prepared solution were tested at various strengths. The commercial brands registered from 31 to 33 degrees on the hydrometer scale. They were used alone and in combination with arsenical poisons. This paper contains a brief discussion of these experiments, with suggestions as to the substitution of lime-sulphur preparations for Bordeaux mixture in the treatment of apple diseases.

#### THE IMPORTANCE OF CAREFUL SPRAYING.

The acreage in apple orchards in this country is rapidly increasing, and in the future the production of apples will undoubtedly be much greater than at present. The writer is of the opinion, however, that there will be no serious overproduction and that there will always be a good demand for good apples, while the poor stuff so common on our markets to-day will not pay the expenses of handling. It should be the aim of every orchardist to produce and market nothing but first-class fruit, and if he does this he may reasonably expect always to obtain good returns from his investment.

Spraying is the one operation above every other orchard practice which determines the market value of the fruit produced and yet in many instances it receives the least attention of all the orchard work. The successful orchardist of the future will be the man who, among other things, studies the conditions existing on his own farm and sprays his trees according to the needs of each variety for the control of the particular troubles which occur in his locality. The course of treatment best suited for the orchards of the Shenandoah Valley of Virginia may not necessarily give the best results in orchards situated east of the Blue Ridge in that State, and again the treatment for certain varieties of apples may be different from that required for certain other varieties growing in the same locality. The course of treatment should be planned not only with reference to the diseases to be controlled, but also with reference to the probable effect of the fungicide upon the fruit and foliage of the variety to be treated. The Ben Davis, for example, is so seriously russeted by applications of Bordeaux mixture that often most of the fruit sprayed with this fungicide is rendered second class. In Virginia this variety does not suffer materially from the attacks of scab, bitter-rot, or other serious fruit diseases, the leaf-spot which is easily controlled being its chief fungous enemy. The Ben Davis in Virginia and in

other similar situations may therefore be successfully sprayed with a weak fungicide which will control the leaf-spot, sooty fungus, and slight scab infections without injury to the fruit or foliage. The York Imperial is another variety which has no serious disease of the fruit, and in addition it is not subject to Bordeaux russet, so common on the Ben Davis, but the foliage is susceptible to leaf-spot and is often badly injured by applications of Bordeaux mixture, so that it is desirable to spray this variety also with a less caustic mixture.

On the other hand, the Yellow Newtown<sup>a</sup> is seriously subject to the attacks of bitter-rot and must be treated with a strong fungicide, such as Bordeaux mixture, for the control of this disease. The fruit of this variety is susceptible to Bordeaux injury, but since such injury is produced only by the early applications of the mixture the treatment may be so planned as to avoid it. One of the lime-sulphur sprays may be used for the first and second sprayings after the petals fall and Bordeaux mixture for the bitter-rot treatments which come later in the season. These are some of the finer points to be considered in connection with spraying, and the orchardist who gives them due consideration will obtain the best results in the production of good fruit.

#### VIRGINIA SPRAYING EXPERIMENTS.

In Virginia during the season of 1909 the writer, with the assistance of Mr. Leslie Pierce, conducted experiments with various lime-sulphur preparations in comparison with Bordeaux mixture for the control of apple diseases. The experiments were made on the Yellow Newtown, at Crozet; the Winesap, York Imperial, and Ben Davis, at Fishersville; and the York Imperial and Ben Davis, at Mount Jackson.

The self-boiled lime-sulphur mixture, the home-boiled lime-sulphur solution, and the commercial lime-sulphur solution, as well as Bordeaux mixture, were used. The self-boiled mixture was used in two strengths, 8-8-50<sup>b</sup> and 10-10-50 and the home-boiled solution at a strength of 5 pounds of sulphur and 2½ pounds of lime to 50 gallons of water, made by boiling the lime and the sulphur with a small quantity of water over a fire for forty-five minutes. The latter is essentially of the same composition as the concentrated lime-sulphur solution which Prof. John P. Stewart<sup>c</sup> described and which, according to him, can be kept indefinitely. The commercial lime-sulphur solution was used at the rates of 1½, 1¾, 2, and 2½ gal-

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<sup>a</sup> Synonym of Albemarle Pippin.

<sup>b</sup> Whenever formulas for lime-sulphur mixture are mentioned in this paper the first number shows the number of pounds of lime used, the second the number of pounds of sulphur, and the last the number of gallons of water.

<sup>c</sup> Bulletin 92, Pennsylvania Agricultural Experiment Station. 1909.

lons to 50 gallons of water. Arsenate of lead at the rate of 2 pounds to 50 gallons was used with the self-boiled mixture, the home-boiled solution, and the Bordeaux mixture. The commercial solution was used with arsenate of lead at the rate of 2 pounds to 50 gallons, with Paris green at the rate of 6 ounces to 50 gallons, and without any poison. In the Mount Jackson orchard the trees were sprayed: First, as soon as the petals fell; second, three to four weeks after the petals fell; and third, nine to ten weeks after the petals fell. The Fishersville orchard, on account of scab, received an additional application, which was made just before the trees bloomed. The Crozet orchard received the same treatment as the Mount Jackson orchard, and on account of bitter-rot a fourth application three to four weeks after the third.

In the same orchards spraying demonstrations for the control of insects and diseases were conducted jointly by the Bureau of Entomology and the Bureau of Plant Industry, following the schedules of applications just mentioned, which were prepared by Mr. A. L. Quaintance and the writer, the former being responsible for that portion relating to insect control. A discussion of these demonstrations will not be included in the present paper.

#### THE EFFECT OF THE SPRAYS ON THE FOLIAGE.

One of the objects of these experiments was to determine the effect of the several lime-sulphur preparations in combination with arsenicals on the foliage of different varieties. Several times at intervals during the season notes were made on the condition of the foliage of the trees in the experimental plats. The weather was mostly cloudy and rainy from early spring until about July 1, so that the conditions were favorable to the development of spray injury. During the latter half of the season, however, practically no rain fell.

In every case, except on the Winesap, where Paris green was used with the commercial lime-sulphur solutions, the foliage was badly burned and in some instances the trees sprayed with this combination lost half of their foliage. The Winesap did not suffer so much injury from this or any of the other sprays as did the other varieties. This variety was used in the experiments of the previous year conducted in Nebraska by the Bureau of Plant Industry, and the fact that the commercial solution at the rate of 2 gallons to 50 gallons of water and 6 ounces of Paris green caused only a slight damage to the foliage indicated that the combination might be practicable. It is evident, however, from the Virginia experiments that it is entirely unsafe to use Paris green with the lime-sulphur sprays.

The commercial lime-sulphur solution at the rate of  $1\frac{1}{2}$  gallons to 50 gallons of water and 2 pounds of arsenate of lead injured the foliage

only slightly, scarcely enough to be noticeable to the casual observer. At the rate of 2 gallons to 50 gallons of water with arsenate of lead this preparation injured the foliage considerably, so that a small percentage of the leaves dropped off. (See Pl. I, fig. 1.) This injury was manifested by a slight scorching around the margins and at the tips of the leaves, and in some cases by the formation of irregular brown spots. Even here, however, the injury was scarcely more severe than that caused by 3-3-50 Bordeaux mixture<sup>a</sup> on the same varieties. (See Pl. I, fig. 2.)

At a strength of 2 to 50 without any poison the commercial solution injured the foliage slightly more than the same mixture with the addition of arsenate of lead. The same is true of the 1½ to 50 strength. The arsenate of lead apparently reduced the caustic properties of the sulphids, rendering the mixture less injurious to apple foliage. This is probably due to the fact that a portion of the sulphur is taken out of solution to combine with the lead, forming lead sulphid and arsenate of lime.

The same solution at a strength of 2½ gallons to 50 gallons of water with and without arsenate of lead injured the foliage very badly, causing a partial defoliation of the trees. This is much too strong for use in the Eastern States, although Professor Beattie,<sup>b</sup> of Washington State, recommended even a stronger solution.

It appears from these tests that 2 gallons of the commercial solution to 50 gallons of water is the maximum strength that can be used on apple foliage with any degree of safety, and that 1½ to 50 is much safer and is about as strong as one should risk in spraying a large orchard.

The home-boiled solution, containing 5 pounds of sulphur and 2½ pounds of lime to 50 gallons of water, with 2 pounds of arsenate of lead, caused very little or practically no injury. This is practically the same as the commercial solution diluted to contain 2 gallons to 50 gallons of water, but the foliage injury caused by the latter was more conspicuous.

The self-boiled lime-sulphur and arsenate of lead caused no injury whatever; in fact, the foliage sprayed with this mixture had a bright-green, vigorous appearance throughout the season. (See Pl. II, fig. 1.) The leaves were noticeably larger, the buds were plumper, and the trees made more growth than those sprayed with the other lime-sulphur preparations and with Bordeaux mixture.

The Bordeaux mixture caused considerable spotting and yellowing of the leaves on the York Imperial, Ben Davis, and Yellow Newtown,

<sup>a</sup>Whenever formulas for Bordeaux mixture are given in this paper, the first number indicates the number of pounds of copper sulphate used; the second, the number of pounds of stone lime; and the last, the number of gallons of water.

<sup>b</sup>Western Fruit Grower, January, 1909, pp. 6-7.

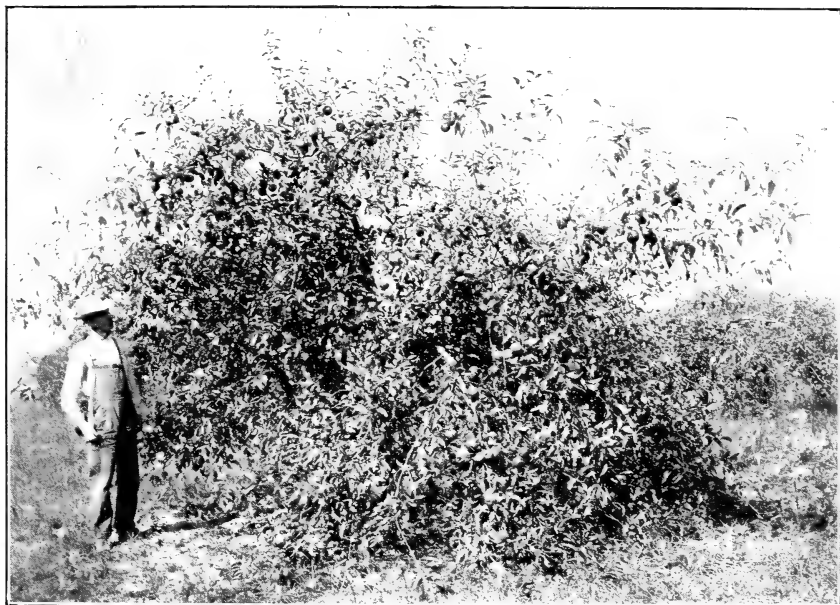


FIG. 1.—BEN DAVIS TREES SPRAYED WITH COMMERCIAL LIME-SULPHUR (2 TO 50), SHOWING SOME LEAF INJURY. FISHERSVILLE, VA., SEPTEMBER 29, 1909.

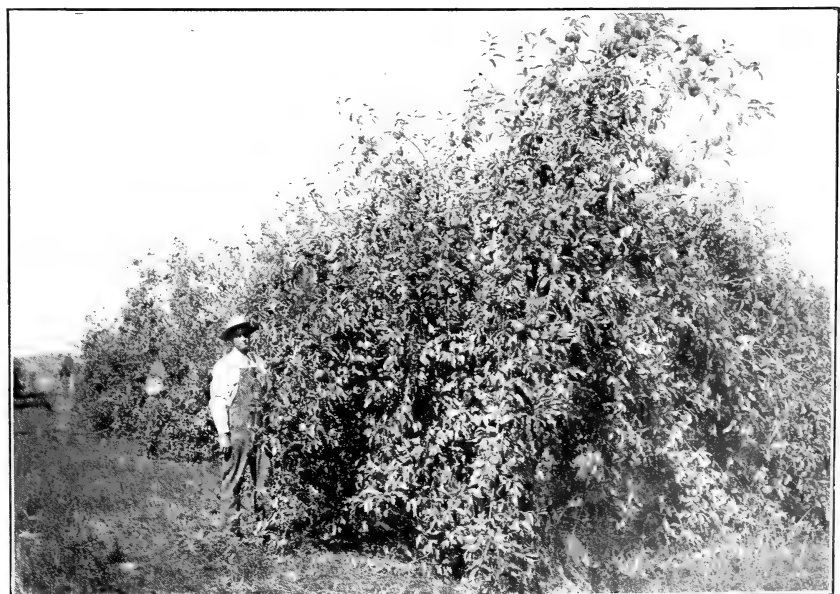
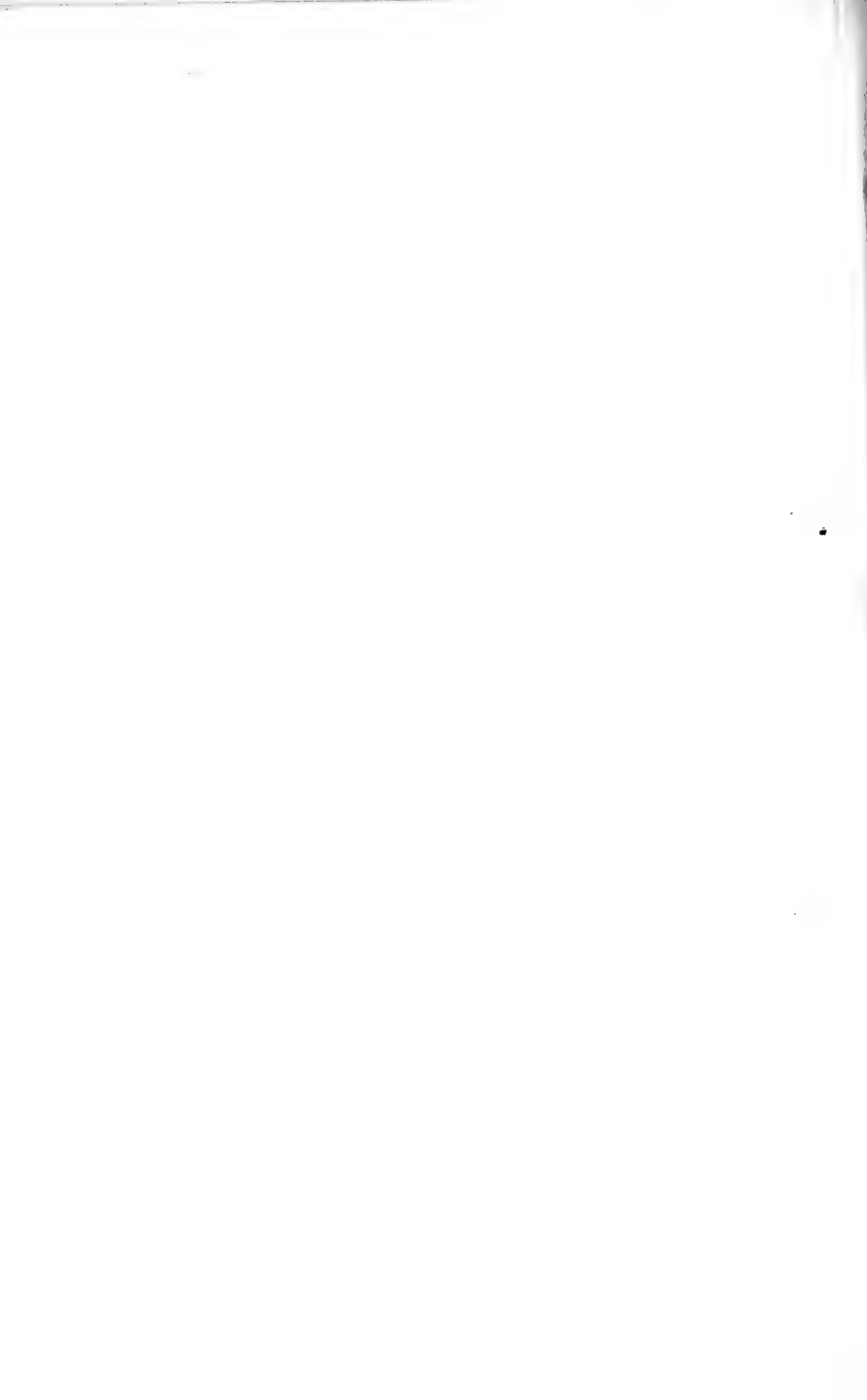


FIG. 2.—A ROW OF BEN DAVIS TREES SPRAYED WITH BORDEAUX MIXTURE. FISHERSVILLE, VA., SEPTEMBER 29, 1909.



but very little on the Winesap variety. Some of the injured leaves dropped from time to time, so that the foliage on many trees was somewhat thinned out toward the end of the season, but the damage could not be considered very serious.

#### THE CONTROL OF DISEASES.

In the orchards in Virginia where these experiments were conducted none of the apple diseases except leaf-spot developed to a serious extent, so that the test was not a severe one. The apple leaf-spot, so common throughout this State, was entirely controlled by all the mixtures used. The self-boiled lime-sulphur made the best showing in this connection, because it not only controlled the leaf-spot but did not injure the foliage, and apparently had a stimulating effect on the trees. (See Pl. II.) All the lime-sulphur preparations, as well as the Bordeaux mixture, controlled the sooty fungus and an undetermined "fruit spot" which was common the past season in Virginia. The weather was so dry after midsummer that bitter-rot did not develop sufficiently to test the value of the lime-sulphur sprays for its control.

Considerable scab developed on the unsprayed Winesaps in the Fishersville orchard, so that a partial test of the efficacy of the several sprays in the control of this disease was afforded. Only one strength (2 to 50) of the commercial lime-sulphur was used on this variety. The crop from four trees in each of the more important plats was picked and sorted, and the results are shown in the following table:

TABLE I.—*Results of the use of lime-sulphur preparations and Bordeaux mixture with arsenicals in the prevention of scab and codling-moth injury on Winesap apples in Virginia.*

No. of plat.	Spray mixture used.	Scabby fruit.	Fruit injured by codling moth.
		<i>Per cent.</i>	<i>Per cent.</i>
2	Commercial lime-sulphur solution (2 to 50) and Paris green. . . . .	0.63	6.90
3	Commercial lime-sulphur solution (2 to 50) and arsenate of lead. . . . .	.51	1.25
4	Self-boiled lime-sulphur solution (10-10-50) and arsenate of lead. . . . .	3.75	1.40
6	Bordeaux mixture (3-3-50) and arsenate of lead. . . . .	2.15	.53
8	Check; not sprayed. . . . .	30.27	36.70

It will be seen from this table that the scab was held down to less than 1 per cent of the crop by the commercial lime-sulphur, to  $3\frac{3}{4}$  per cent by self-boiled lime-sulphur, and to about 2 per cent by Bordeaux mixture, and that 30 per cent of the unsprayed fruit was affected with the disease. This disease was well controlled by all the mixtures, but it will be noted that it was not particularly bad on the unsprayed trees, so that the test could not be considered a severe one. None of the Winesaps were sprayed with the weaker commercial preparations nor with the home-boiled lime-sulphur.

In this experiment the comparative effect of the different mixtures on the codling moth was determined, and, as shown in Table I, the combination of lime-sulphur and arsenate of lead controlled this insect about as well as Bordeaux mixture and arsenate of lead. It seems, therefore, that the poisonous action of this arsenical is not reduced by combining it with the lime-sulphur preparation.

#### THE EFFECT OF THE SPRAYS ON THE FRUIT.

In all the orchards treated the fruit sprayed with the several lime-sulphur mixtures was smoother and more highly colored than that sprayed with Bordeaux mixture. The Bordeaux mixture russeted the fruit of the Ben Davis so that it did not have the "finish" required for fancy apples, and a small percentage of it had to be discarded as culls on account of the roughened appearance due to the mixture. The Yellow Newtowns were russeted considerably and the Winesaps only slightly, while the York Imperials showed practically no russet effect.

The lime-sulphur preparations caused no russeting, or at most very little where the strongest solutions were used, and the fruit sprayed with these mixtures was smooth, clean, and well colored. The difference in color between the fruit sprayed with the Bordeaux and that sprayed with the several lime-sulphur preparations was very striking, and this feature alone would make the latter sprays preferable to the former if other things were equal.

#### EXPERIMENTS IN MICHIGAN.

Experiments similar to those in Virginia were conducted at Douglas, Mich., in cooperation with the Bureau of Entomology, and the results were much the same. The work was done by Mr. R. W. Braucher under the writer's direction in the orchard of Mr. C. W. Gaylord. The trees were sprayed just before they bloomed (May 19 and 20), as soon as the petals fell (June 1 and 2), three weeks later (June 23 and 24), and ten weeks after the petals fell (August 10 and 11).

There were six plats of from 13 to 20 trees each, including the Wagener, Baldwin, Rhode Island, Roxbury, and Ben Davis varieties. The commercial lime-sulphur solution, diluted to contain 2 gallons to 50 gallons of water, without any arsenical, was applied to plat 1; the same solution, with the addition of 6 ounces of Paris green, was applied to plat 2; and the same solution, with the addition of 2 pounds of arsenate of lead, was used on plat 3. Plat 4 was sprayed with self-boiled lime-sulphur (10-10-50) and 2 pounds of arsenate of lead, and plat 5 was sprayed with 3-4-50 Bordeaux mixture and 2 pounds of arsenate of lead, while plat 6 was left unsprayed. The plats sprayed with the commercial lime-sulphur solution, espe-





FIG. 1.—YORK IMPERIAL APPLE TREE SPRAYED WITH SELF-BOILED LIME-SULPHUR, SHOWING LUXURIANT FOLIAGE. FISHERSVILLE, VA., SEPTEMBER 29, 1909.

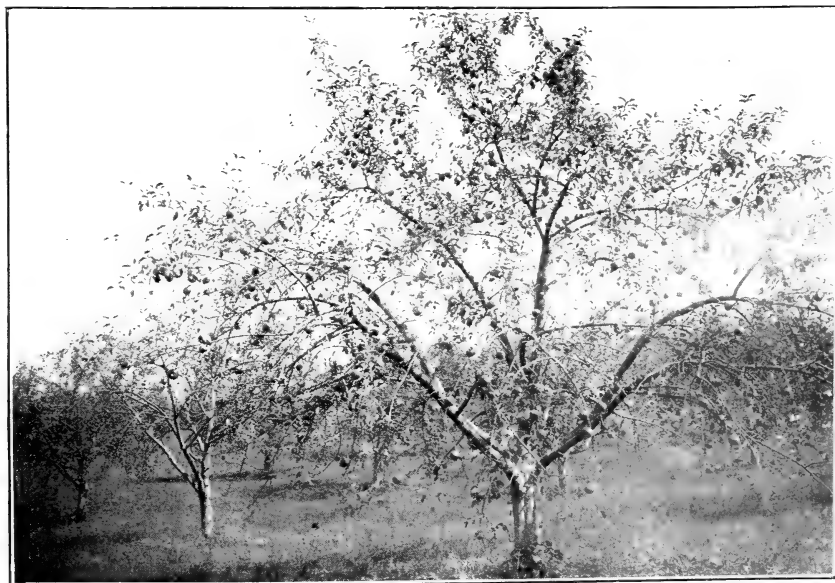


FIG. 2.—UNSPRAYED YORK IMPERIAL APPLE TREES ALMOST DEFOLIATED BY LEAF-SPOT, LOCATED IN THE SAME ORCHARD AND PHOTOGRAPHED AT THE SAME TIME AS THAT SHOWN IN FIGURE 1.



cially plat 2, began to show considerable foliage injury after the second application, and on this account the solution was diluted to contain only 1 gallon in 40 gallons of water for the last two sprayings.

#### RESULTS OF THE TREATMENT.

Soon after the second application was made, according to Mr. Braucher's notes, the commercial lime-sulphur plats began to show foliage injury. Notes made at intervals during the season show that the foliage was quite badly injured by the lime-sulphur solution and Paris green combination and that the solution without an arsenical caused almost as much damage, while the same solution with arsenate of lead was much less injurious. Although the damage caused by the lime-sulphur and arsenate of lead combination was not severe, it was sufficient to discourage the use of the solution at the strength of 2 gallons to 50 gallons of water. A strength of  $1\frac{1}{2}$  gallons to 50 gallons of water, with arsenate of lead, proved to be practically noninjurious in Virginia and would probably be safe in Michigan. The self-boiled lime-sulphur mixture with arsenate of lead caused no damage whatever.

The following table shows the efficiency of the several spray mixtures in preventing apple scab on the Wagener variety, as determined by sorting and counting the fruit from eight trees in each plat:

TABLE II.—*Comparison of results of the use of lime-sulphur sprays with Bordeaux mixture in the prevention of scab on Wagener apples at Douglas, Mich.*

No. of plat.	Spray mixture used.	Scabby fruit.
		<i>Per cent.</i>
1	Commercial lime-sulphur solution (2 to 50) .....	6.37
2	Commercial lime-sulphur solution (2 to 50) and 6 ounces of Paris green .....	2.23
3	Commercial lime-sulphur solution (2 to 50) and 2 pounds of arsenate of lead .....	3.96
4	Self-boiled lime-sulphur solution (10-10-50) and 2 pounds of arsenate of lead .....	19.48
5	Bordeaux mixture (3-4-50) and 2 pounds of arsenate of lead .....	3.43
6	Check; not sprayed .....	81.18

As shown in the above table, the scab was held down to an average of 4.2 per cent of the crop by the commercial lime-sulphur solution, to 3.43 per cent by the Bordeaux mixture, and to 19.48 per cent by the self-boiled mixture, while 81 per cent of the unsprayed fruit was scabby. (See Pl. III.) This experiment, as well as those conducted in Virginia, shows that the lime-sulphur solution is as effective in preventing apple scab as Bordeaux mixture, while the self-boiled wash is not so good in this connection. The arsenate of lead in the commercial lime-sulphur solution held the codling moth down to 1.6 per cent of the crop and in the case of Bordeaux mixture to 5.6 per cent, thus indicating that the lime-sulphur does not injuriously affect the poison.

## EXPERIMENTS IN ARKANSAS.

At Siloam Springs, Ark., during 1909, Messrs. F. W. Faurot and E. L. Jenne, of the Bureau of Entomology, conducted another set of experiments under the writer's directions. The results of those experiments throw considerable doubt on both the efficiency and safety of the commercial lime-sulphur solution as a summer spray for apple diseases. The Ben Davis, Shannon, Arkansas, and Elkhorn varieties were sprayed with several different strengths of the commercial preparation in combination with arsenical poisons. The self-boiled lime-sulphur solution and the Bordeaux mixture were also used. The trees were sprayed five times, as follows: (1) As soon as the petals fell; (2) three weeks later; (3) eight to nine weeks after the petals fell; (4) two weeks later, and (5) three weeks after the fourth application.

## RESULTS OF THE TREATMENT.

The trees sprayed with commercial lime-sulphur solution diluted to contain 1 gallon in 30 gallons of water, with the addition of the usual amount of arsenate of lead, showed very little or practically no foliage injury after the first and second applications; in fact, according to notes made on June 30 and July 22, no serious injury followed the third treatment, which was applied on June 2. After the fifth application, however, the injury increased rapidly, and at picking time half of the leaves were on the ground. It seems that the injurious effect of the mixture was cumulative, the injury being increased by each application. Three applications would, perhaps, have resulted in little or no damage, but five sprayings were evidently more than the trees could stand. Considerable rain fell during May and June, but the remainder of the season was dry. The trees suffered severely from drought, which apparently exaggerated the spray injury. On account of the shortage of foliage on the trees a portion of the fruit was sunburned, but no russeting was caused by the spray. This sunburning also occurred on the fruit sprayed with Bordeaux mixture, but to a much less extent.

The commercial lime-sulphur at a strength of 1 to 30 in combination with Paris green began to burn the foliage soon after the first application was made, and by midsummer the trees were almost bare. Arsenite of lime was also used with the 1 to 30 solution, and the results were disastrous. The foliage was burned to a crisp and the fruit badly scorched by the first application. Even the new twig growth was killed to a considerable extent.

The self-boiled lime-sulphur and arsenate of lead caused no injury to fruit or foliage. The fruit sprayed with Bordeaux mixture was quite badly russeted and the foliage suffered considerable injury.

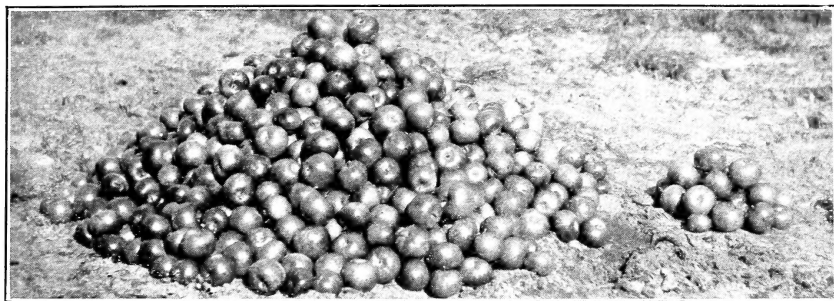


FIG. 1.—APPLES SPRAYED WITH COMMERCIAL LIME-SULPHUR. SCABBY FRUIT ON THE RIGHT.

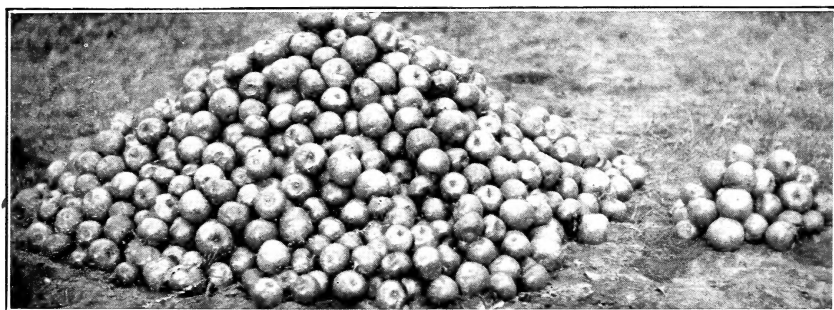


FIG. 2.—APPLES SPRAYED WITH BORDEAUX MIXTURE. SCABBY FRUIT ON THE RIGHT.

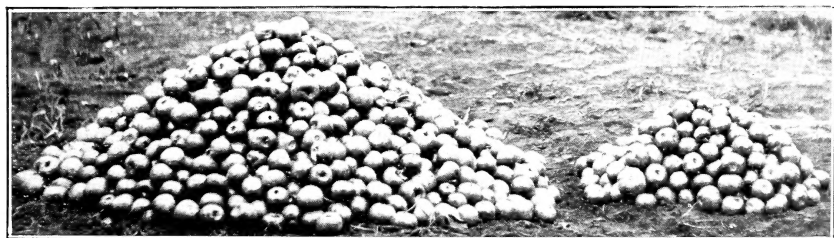


FIG. 3.—APPLES SPRAYED WITH SELF-BOILED LIME-SULPHUR. SCABBY FRUIT ON THE RIGHT.

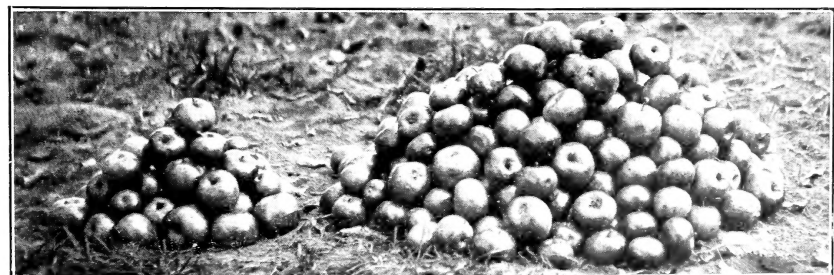


FIG. 4.—UNSPRAYED APPLES. SCABBY FRUIT ON THE RIGHT.

