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ORCHARD SPRAYING EXPERIMENTS IN 1912

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BULLETIN No. 212.**ORCHARD SPRAYING EXPERIMENTS IN 1912.**

W. J. MORSE AND G. A. YEATON.

At this Station the first tests of lime-sulphur as a substitute for bordeaux mixture in spraying apple orchards was made in 1908. This was an experiment planned and conducted by the Department of Plant Pathology, the results being reported in Bulletin 164. In this work self-boiled lime-sulphur was prepared by using both hot and cold water and was compared with bordeaux mixture to test its efficiency in the control of apple scab. Five varieties of apples were used, including the Fameuse and the McIntosh, both of which are quite susceptible to scab.

Although three applications of the sprays were made, the first when the leaves were unfolding, the second just after the petals fell, and the third about three weeks later, considerable scab developed on all of the sprayed trees. While the results from the self-boiled lime-sulphur showed that it had materially reduced the amount of scab the bordeaux mixture showed much more efficient control of the disease. However the test was a severe one and 99 per cent of the apples on the unsprayed trees were scabbed.

The same experiment was repeated in 1909 in the same orchard but, on account of weather conditions, that season scab failed to develop even on the unsprayed trees, consequently the results were inconclusive and were not written up for publication. Neither in 1908 nor in 1909 was there any spray injury to be observed on foliage or fruit, even where the bordeaux mixture was used.

Highmoor Farm came under the management of the Maine Agricultural Experiment Station on July 1, 1909, and the orchards, which now consist of over 2300 trees, furnished the

Station for the first time in its history an opportunity to make spraying experiments on a large scale in an orchard entirely under its control. By this time the results of experiments made in other parts of the country indicated that a concentrated mixture of lime and sulphur in water, cooked by artificial heat and then diluted before applying, was the most promising lime-sulphur spray for apple orchards. It was claimed to be more effective than the self-boiled article and entirely free from spray injury, thus, in this respect, being much superior to bordeaux mixture.

Therefore an experiment was planned for 1910 as one of the plant pathology projects for that year in which it was proposed to test the value of artificially boiled or cooked lime-sulphur as an orchard spray, as compared with the self-boiled and with bordeaux mixture. Also it was planned to test the relative efficiency of several commercial brands of concentrated, boiled lime-sulphur as compared with the home-cooked article. With the appointment of Mr. W. W. Bonns as Station Horticulturist, stationed at Highmoor Farm, the project was transferred to his department. Mr. Bonns carried on two series of experiments, one in 1910 and one in 1911, the results of which were quite fully reported in Bulletins 189 and 198. In the first publication, in addition to giving an account of the results of the experimental work of the season, he reviewed in considerable detail the literature upon the use of lime-sulphur as a summer spray, the use of sulphur and its compounds as fungicides, the question of spray injury from bordeaux mixture, etc. On account of the great demand for Bulletin 189 it was soon out of print. Therefore a summary of the experimental results obtained in 1910 were included in Bulletin 198 with those obtained in 1911.

The apple orchards at Highmoor Farm consist almost entirely of the Ben Davis and Baldwin varieties. The entire orchards were sprayed once late in June 1909 with bordeaux mixture and arsenate of lead, largely to control leaf-eating insects, just as soon as it was found that the purchasing committee had decided to buy this farm. So far as known this was the first time the trees, which were then in a much neglected, half-starved condition, had ever been sprayed. In 1910 all but the experimental plots received three applications of bordeaux mixture and arse-

nate of lead. During both seasons much damage from spray injury resulted to both foliage and fruit, particularly on the Ben Davis. Since 1910 the main orchards have been sprayed yearly with home-cooked lime-sulphur and with uniform success as far as spray injury was concerned.

On account of weather conditions no real severe test of lime-sulphur as a means of control of apple scab was experienced until the present year, although the data secured in 1910 were sufficiently conclusive for practical purposes with regard to certain questions under consideration. The artificially cooked lime-sulphur gave that year, as a rule, much better results as to scab control than did the self-boiled article. The results in 1910 were also slightly in its favor in this respect when compared with bordeaux mixture. The commercial brands of concentrated lime-sulphur were, during that season, somewhat more effective than the home-cooked material, but this advantage was not considered sufficient to offset the greater cost of the former for large orchards.

With regard to injury to foliage and fruit all of the lime-sulphur sprays proved to be much more satisfactory than bordeaux mixture, although one proprietary spray, the name of which indicated that it was some sort of a sulphur compound, produced much greater spray injury than did bordeaux mixture. However, in these orchards of over 2300 trees, mostly Ben Davis and Baldwin, wherever bordeaux mixture has been used during the past four years the resulting injury to foliage and fruit has, as a rule, more than offset the benefits derived from fungus control. It will be seen later that during 1912, while the foliage escaped, much russetting was produced on the fruit. On the other hand, properly made and properly applied lime-sulphur has produced practically no foliage injury and very little russetting of the fruit could be attributed to it. At the same time when applied at the proper time, particularly in the experiments to be described in this bulletin, it was quite effective in the control of the apple scab fungus on both foliage and fruit.

While it has been shown conclusively in these experiments and those conducted elsewhere that lime-sulphur is a much safer spray to use on those varieties of apples like the Ben Davis which are very susceptible to spray injury, there are certain varieties of apples which are not injured or are but slightly

injured by bordeaux mixture. Moreover the work of Stewart and his associates of the New York Station has shown that lime-sulphur not only is far inferior to bordeaux mixture as an agent to control the late blight and other potato leaf-diseases, but it is apparently positively detrimental to the potato.* Therefore it seemed justifiable to plan a series of experiments extending over a number of years in which the relative efficiency of bordeaux mixture and lime-sulphur as a spray for apple orchards could be tested under a variety of seasonal weather conditions. While the reports are everywhere quite favorable to lime-sulphur, as an orchard spray the data so far accumulated are not sufficiently varied and complete to draw final conclusions. If bordeaux mixture is more effective or even equally effective in scab control there is no reason for the orchardist who experiences no injury from it upon the varieties which he grows to discard it in favor of lime-sulphur.

Certain writers, a summary of whose work Mr. Bonns gave in Bulletin 198 have noted the fungicidal value of lead arsenate.† Therefore the experiments for 1911 were so planned as to include a test of the fungicidal value of lead arsenate, further comparisons of the fungicidal value of bordeaux mixture and home-cooked lime-sulphur, and a test of different dilutions of lime-sulphur to determine which is the most satisfactory strength to use, both with regard to control of scab and freedom from spray injury. The variety used for making these tests in all cases being the Ben Davis.

On account of weather conditions being unfavorable to the growth of the fungus practically no scab developed in the orchards in 1911 so that from that standpoint no data of value was secured. In fact on account of the failure of scab to develop the only clear-cut result of the experimental spraying of that year was with regards russetting the fruit. Where bordeaux

* Stewart, F. C. and French, G. T., Lime-Sulphur vs. Bordeaux Mixture as a Spray for Potatoes. Bul. N. Y. Agr. Exp. Sta. 347, 1911. Munn, M. T., Lime Sulphur vs. Bordeaux Mixture as a Spray for Potatoes II. Bul. N. Y. Agr. Exp. Sta. 352, 1912.

† Taylor, E. P., Spraying Peaches for Brown Rot, Western Fruit Grower, pp. 20-21, Oct. 1909, pp. 16-18, Feb. 1910.

Wait, M. B. Experiments on the Apple with Some New and Little Known Fungicides. Cir. U. S. D. A. Bu. Pl. Ind. 58, 1910.

Wallace, E., Blodgett, F. M. and Hessler, L. R. Studies of the Fungicidal Value of Lime Sulphur. Bul. Cornell Agr. Exp. Sta. 290, 1911.

mixture was used over 70 per cent of the apples were so affected while on the other plots this was not over 2 per cent in any case and the amount was fairly uniform, regardless of the kind and strength of the spray.

THE 1912 EXPERIMENTS.

In 1912 the apple spraying experiments were again transferred to the Department of Plant Pathology. When the first two applications of the spray were applied in the experiments which will be described the Station pathologist was on a leave of absence, otherwise an unsprayed check-plot would have been saved for comparison. That part of the work which was primarily concerned with the fungicidal value of the different sprays was an exact duplicate of that carried out the season before, but as has already been pointed out the weather conditions of the summer of 1912 were much more favorable to the test.

In this experiment there were used 139 Ben Davis trees, about twenty-five years old and which constituted a block at one corner of the most thrifty orchard on the farm. This is the same block of trees which was used in 1910 and 1911 experiments. Previous to 1909 this orchard, like the others on the farm, had been much neglected, although it showed some evidence of previous cultivation and had also been used for a sheep pasture in recent years. For the past three years it has been well fertilized and has been thoroughly cultivated each year. It is now in a quite thrifty condition. The block was divided into six different plots.

Plot A was sprayed with arsenate of lead 4 pounds in 50 gallons of water.

Plot B was sprayed with home-cooked lime-sulphur, 27° Beaumé density 2 gallons, in water sufficient to make 50 gallons. This was called the "one-fifth stronger" plot as the spray carried 20 per cent more of the concentrate than is commonly recommended.

Plot C or the "standard dilution" plot was sprayed with 1 2-3 gallons of the same lime-sulphur concentrate, diluted with water to make 50 gallons. This is the same dilution as is used on the general orchards on the farm.

Plot D was called the "one-fourth weaker" plot as only 11-4 gallons or 25 per cent less of the concentrate than in Plot C was used to each 50 gallons of the spray.

Plot E was sprayed with 2 pounds of arsenate of lead in 50 gallons of water.

Plot F was sprayed with a 3-3-50 bordeaux mixture.

Two pounds of arsenate of lead were added to the spray in each case on plots B, C, D and F. All of the sprays were applied with a gasoline power sprayer outfit, using two leads of hose at a time at about 150 pounds pressure. Care was taken to thoroughly wash out both the tank and the pump after using each different kind of spray, before putting in the next. The relative position of the plots and the number of trees in each are best shown in the following plan.

PLAN OF EXPERIMENT.

[illegible]

As originally planned three applications of the sprays were to be made, the first just as the blossoms were showing pink, the second after the petals fell and the third about three weeks later. The early part of the season was very wet and for several days before the first application should have been made it rained almost constantly. Partly on this account and partly on account of a misunderstanding on the part of those in charge of the work at that time the first application of the sprays on the experimental plots was delayed so long that the blossoms opened before it could be applied. Fortunately, on the orchard adjoining the plot, where exactly similar conditions existed with regards soil, age, variety and condition of the trees, this first application was made just before the blossoms opened. Hence this furnished opportunity to select a plot of trees sprayed three

times with standard dilution lime-sulphur and where the applications were made at the proper dates as was intended in the original experiment. As will be seen later the results from this block of trees furnished an excellent demonstration, when compared with the other experimental plots, of the value of a fungicidal spray for apple scab when applied just before the blossoms open. This plot will be referred to as Plot G.

Plots A to F inclusive were sprayed first on June 5 and again on July 1. Plot G was sprayed on May 24, June 5 and July 1.

EFFECT OF THE SPRAYS ON THE FOLIAGE.

The experimental plots were under the constant observation of the orchardist, Mr. Yeaton, and were frequently visited by Dr. Lewis, the associate pathologist, and the writer during the season.

On June 5 there was no evidence of scab in any of the orchards. On plot G where the first application of lime-sulphur was made on May 24 there was no evidence of spray injury although an occasional leaf showed scorching at the margin.

Plot A, 4 pounds of arsenate of lead with no fungicide, showed a small amount of scab on the leaves of all of the trees, some leaves being quite badly affected on the first of July. No spray injury was noted at that time. By the middle of July the scab had not developed much more but there was by this time abundance of spray injury on the leaves. By August first the foliage still plainly showed the effects of spray injury but the evidences of scab on the leaves had largely disappeared. A record was also kept on the appearance and development of scab on the fruit on this and other plots but this will be discussed under another heading.

Plot B, sprayed with 2 gallons of lime-sulphur and 2 pounds of arsenate of lead diluted to 50 gallons, showed a quite general infestation of scab on the leaves by July 1. However, while some of the leaves on all of the trees in this plot were attacked, the infestation was, on the whole, recorded as slight as compared with plots C, D, and E. By the middle of July there was not much evidence of farther development of scab, but some

spray injury was plainly evident on the foliage. This was, however, frequently plainly associated with scab spots and suggested that it might be analogous to arsenical injury on potato leaves which have been injured by flea beetles. A given amount of Paris green or other arsenical may be used on potato plants with perfect safety so long as the epidermis of the leaves is unbroken. On the other hand, if a considerable number of flea-beetle punctures are present in the leaves arsenical injury is quite likely to result, the severity of the injury varying with the number of punctures.

By August 1 the evidence of scab infestation on this plot had largely disappeared and no increase of the amount of spray injury on the foliage was observed during the remainder of the season.

Plot C sprayed with 1 2-3 gallons of lime-sulphur and 2 pounds of arsenate of lead diluted to 50 gallons. Detailed records made of the amount of scab on the leaves of the individual trees in this plot at various times during the season showed relatively more scab was present than on plot B, where the "one-fifth stronger" dilution of lime-sulphur was used. On the other hand very little leaf-spot or spray injury was observed on plot C.

Plot D, sprayed with 1 1-4 gallons of lime-sulphur and 2 pounds of arsenate of lead diluted to 50 gallons. Much more scab was observed on this than on any of the other lime-sulphur plots. Judging from the appearance of the leaves alone, and in comparison with plot E the two applications of this weaker dilution of lime-sulphur failed to exert any restraining influence on the development of the scab fungus whatever, although it will show later that it did reduce somewhat the amount of scab on the fruit.

Plot E, sprayed with 2 pounds of arsenate of lead in 50 gallons of water. With the exception of plot D this showed the greatest development of scab on the foliage of any. In this connection it should be noted that there was a decidedly less amount of scab on the leaves of the trees in plot A where double the amount of arsenate of lead was used without any lime-sulphur. In fact on the last mentioned, considering plot E as a check, the control of scab on the foliage was fully equal to that

on the "standard dilution" plot and nearly equal to that on the "one-fifth stronger" plot.

Plot F, sprayed with a 3-3-50 bordeaux mixture. During the present season if final conclusions were to be based on the effects on the leaves alone bordeaux mixture showed much better results than lime-sulphur. However the final record of the percentages of perfect and imperfect fruit, which are given later, tell a somewhat different story. On plot F, where bordeaux mixture and arsenate of lead was used there was almost perfect control of scab on the foliage and no spray injury of the leaves was observed. On the other hand very severe spray injury to the leaves was experienced on the same variety in previous years.

Plot G, sprayed with "standard dilution" lime-sulphur the same as plot C, except that it received an application on May 24, just before the flower buds opened. On this plot throughout the season the control of scab on the leaves was all that could be asked for, and little or no spray injury was apparent.

EFFECT OF THE SPRAYS ON THE FRUIT.

Notes and observations were made and records kept of the development of scab and the appearance of russeting on the fruit during the season. These records do not give any additional information which is of material value and which is not indicated by the condition of the fruit at the time of harvesting, therefore they are omitted.

The fruit on the trees on the experimental plots under consideration averaged about 3 barrels per tree, giving on the entire area over 400 barrels. So far as could be observed the condition of the fruit on the different trees in each plot was fairly uniform, therefore it seemed to be an unnecessary expenditure of time and labor to attempt to sort and count the entire quantity. For the purpose of obtaining the necessary data the entire crop on 6 trees in each plot was picked separately, placed in barrels and taken to the packing shed for sorting. In all plots except A, E, and F, where this was impossible, the 6 trees constituted one of the rows nearest the center of the plot. The amount of fruit actually used and counted to obtain the data

recorded in the following table amounted to about 20 barrels per plot or treatment. In some cases it ran over this and in others, notably in plot G, it was somewhat less than 20 barrels.

It will be noted in the table that in plot E the percentages total slightly more than 100 while in plot F they amount to considerably more than this. This is accounted for by the fact that in some cases, particularly in plot F the same apples were both scabbed and russeted.

RESULTS OF THE FUNGICIDE EXPERIMENTS ON THE FRUIT.

Plot.	TREATMENT.	Total No. of apples.	Number smooth.	Number scabby.	Number russeted.	*Per cent. of perfect apples.	*Per cent. of scabby apples.	*Per cent. of russeted apples.
A	Arsenate of lead 4 lbs.—water 50 gallons.....	10,507	7,132	2,660	715	67.8	25.3	6.8
B	Lime-sulphur 2 gals.—arse- nate of lead 2 lbs.—water 48 gals.....	10,298	7,409	2,520	369	71.8	24.4	3.5
C	Lime-sulphur 1½ gals.—arsenate of lead 2 lbs.—water 48½ gals.	9,312	4,727	4,439	146	50.7	47.6	1.5
D	Lime-sulphur 1½ gals.—arsenate of lead 2 lbs.—water 48½ gals.	9,513	3,450	5,835	228	36.2	60.9	2.3
E	Arsenate of lead 2 lbs.—water 50 gals.....	9,935	1,859	8,044	52	18.7	80.6	2.3
F	Bordeaux mixture 3-3-50—arse- nate of lead 2 lbs.....	9,363	5,959	3,048	3,404	63.6	32.5	35.3
G	Lime-sulphur 1½ gals.—arsenate of lead 2 lbs.—water 48½ gals.†	6,733	5,985	95	650	88.8	1.4	9.6

* The per cents. do not total 100 as in some instances a considerable number of the same apples were both scabby and russeted.

† Like plot C except that an application was made just before the flower buds opened.

DISCUSSION OF RESULTS.

As has already been mentioned the original plan of the experiment called for an application of the various sprays when the flower buds began to show pink, or before they opened. The failure to do this greatly lessened the value of the data which it was planned to obtain. Fortunately, however, this omitted spray was applied to the adjoining orchard from which plot G was taken. As a result certain other data were obtained which are doubtless of more practical value than that originally desired.

Efficiency of the first spray application. Perhaps the most striking thing about the results secured is with regards the value of the spray applied before the blossoms opened as compared with the two following applications. This is shown by the figures obtained on plots C and G. The treatment on these two plots being exactly alike except that on C the first spraying was omitted. In one case only about 50 per cent of perfect apples were obtained and nearly all of the remainder of the fruit was scabbed. In the other nearly 90 per cent of the fruit was sound and perfect and less than 1.5 per cent was scabby. It is true that on the last plot nearly 10 per cent were classed as russeted but this figure is somewhat misleading as the russetting was, as a rule, very slight. Very few of these so-called russeted apples would have to be sold for less than a No. 2 grade.

The general conclusion was that, under the existing weather conditions of the past season, where the first spraying was omitted the profits derived from the two following sprayings paid little more than the cost of application. This statement should not be taken as implying that these are not important or advising that they should be omitted, but as pointing out the great importance of the first spraying, applied at the proper time. The more complete knowledge of the life history of the scab fungus which has been gained in recent years coincides with these experimental results.

The fungus passes the winter on fallen leaves under the trees. In early spring on these leaves of the season before it matures within a capsule an entirely different type of spore from that which leads to the propagation and spread of the fungus during the following summer. These sac spores are thrown out in the

spring in large numbers, are carried to the leaves of the lower branches of the trees, and there serve as centers of infection as soon as they have germinated and have begun to produce a diseased area. This period of ejection of the sac spores lasts but for a comparatively short time and then the danger from them is largely past. Consequently if a fungicidal spray is applied to the trees when these spores are being matured and thrown off, or at least before they have germinated and infected the leaves and parts of the young blossom buds, a large proportion of the potential possibilities of scab infestation for the coming season will be eliminated at the start. If, on the other hand, the first application is too long delayed and infection has occurred no amount of later spraying will absolutely control the disease although it may do much to prevent its spread to uninfected fruit and leaves.

That two applications of standard dilution lime-sulphur did materially check the development of scab is plainly shown in comparing plots C and E where the former gave 32 per cent more perfect apples than the latter. On the other hand plot G, sprayed three times, gave a like increase of over 70 per cent. This much greater efficiency in disease control is very evidently due to the prevention of the early spring infection from the sac spores produced on the old leaves under the trees.

Dilution of lime-sulphur. The fact that only two applications were made to the different plots of which the different dilutions of lime-sulphur were tested detracts from the value of the data obtained. While too sweeping conclusions should not be drawn from them, the results taken for their face value are fairly suggestive. The "one-fifth stronger" dilution was decidedly more efficient in scab control than was the "standard dilution" and produced but little more russetting of the fruit. This did, as has been previously noted, produce some slight leaf injury. Judging from this season's experience and that of the year before it would seem that a 27° Baumé lime-sulphur can be used at the rate of two gallons to 48 of water with comparative safety on varieties like the Ben Davis which are very susceptible to spray injury. Judging from the results of the present season alone this stronger dilution is much more efficient than the standard dilution in scab control—possibly sufficiently so to

warrant its use in commercial spraying. However this is a matter which requires more confirmatory evidence.

The "one-fourth weaker" dilution on plot D proved to be entirely inefficient in scab control and doubtless what gains there were did not pay the cost of spraying. While it is very likely that much better results would have been obtained if another application of this spray had been made earlier it is not felt that the results are sufficiently encouraging to warrant following it farther another year.

Lime-sulphur vs. bordeaux mixture. The percentage of perfect apples obtained from the plot sprayed with bordeaux mixture exceeded that produced on those plots sprayed with lime-sulphur the same number of times with the exception of plot B where the strongest lime-sulphur spray was used. Here again, however, the figures do not tell the whole story. Strange as it may seem, practically all of the scabbed apples on the bordeaux sprayed plot were also among the russeted. However, very few of the apples on this plot were very badly affected with scab. On the other hand the scabbed apples on the lime-sulphur sprayed plots were, as a rule, somewhat more seriously affected. While the slightly scabbed apples on the bordeaux plot would doubtless keep in storage better than the slightly more severely attacked fruit on the lime sulphur plots the latter fruit on account of its freedom from spray injury or russetting would bring a higher market price.

Arsenate of lead as a fungicide. Another very striking fact in connection with results obtained was the apparent effectiveness of heavy applications of arsenate of lead in the control of apple scab as is shown by a comparison of the per cent of scabby apples recorded from plots A and E. In one case where 4 pounds of arsenate of lead to 50 gallons of water was used with no other material added as a fungicide only a little over 25 per cent of the fruit was scabbed while in the other case where only half as much arsenate of lead was applied over 80 per cent of the apples were scabby. Moreover it will be seen on reference to the table that where the 4 pounds of arsenate of lead was used alone the percentage of perfect apples obtained was greater than on all other plots which received the same number of applications except B, where the stronger dilution of lime-sulphur was used.

It was in connection with these comparisons that the lack of an unsprayed check-plot was most apparent. Apparently when plots A and C are compared, 4 pounds of arsenate of lead were decidedly more effective in scab control than standard dilution lime-sulphur plus 2 pounds of arsenate of lead. If 4 pounds of arsenate of lead exerts so decided a fungicidal effect, is it not possible that the amount of scab on plot E, sprayed with 2 pounds of arsenate of lead alone, is considerably less than would have developed on an unsprayed plot? If such is the case its use as a check plot does not measure the true fungicidal value of sprays used on the other plots. Similarly how much of the fungicidal value of lime-sulphur combined with arsenate of lead is due to the presence of the last named material? There is one outside factor which may have exerted an influence on the apparent effectiveness as a fungicide of the heavy application of arsenate of lead. As is illustrated on p — the nine trees in this plot were at the corner of the orchard and were thus much better exposed to the sunlight than those on the other plots. However it does not seem that this location with regards light is sufficient to account for the recorded differences.

EXPERIMENTS WITH DIFFERENT ARSENICALS IN COMBINATION WITH LIME-SULPHUR.

The ordinary arsenate of lead paste commonly used for orchard spraying is a very variable substance. Some lots as purchased may be quite soft and carry a considerable percentage of water. Other lots, sometimes from the same manufacturer, are received in the form of a rather dry, sticky paste. This variation in composition may cause considerable variation in the amount of arsenate of lead actually used in the spray no matter how careful the user is to accurately weigh the quantity taken. Also considerable difficulty is frequently experienced in dissolving the arsenate of lead paste, particularly that which has partially dried out, so that it will mix thoroughly and well with the spray. Certain manufacturers are now selling a dry arsenate of lead in powder form which dissolves readily and quickly in water and which, if not adulterated, should always carry the same amount of poison pound for pound. Arsenite of zinc is also being sold as a substitute for arsenate of lead.

While the use of these substances as a substitute for the ordinary form of arsenate of lead as an insecticide is primarily a problem of economic entomology, their effects upon foliage and fruit, injurious or otherwise, are matters which concern the pathologist. Therefore an experiment was conducted, with the object in view of determining whether or not these substitutes produce injurious effects, in which the ordinary form of arsenate of lead paste was compared with the dried or powdered arsenate of lead and the arsenite of zinc.

For this Ben Davis trees were used in blocks of 36 trees each. The records were taken on the fruit from one row of 6 trees near the center of the plot as was the case in the fungicide experiments. So far as could be observed none of the insecticides, all of which were used in connection with standard dilution lime-sulphur, produced any appreciable injury to the foliage. Three pounds of arsenate of lead paste, 1 1-2 pounds of the dry arsenate of lead and one pound of arsenite of zinc were used with each 50 gallons of the lime-sulphur spray. The following gives in tabular form the condition of the fruit when harvested.

RESULTS OF THE INSECTICIDE EXPERIMENTS ON THE FRUIT.

TREATMENT.	Total No. of apples.	Number sound.	Number wormy.	Number russeted.	Per cent. of sound apples.
Arsenate of lead paste.....	6733	6080	3	650	90
Arsenate of lead dry.....	3594	3383	2	209	94
Arsenite of zinc.....	5790	5485	5	300	93

In the above table the term "sound" is used to include all apples which were not attacked by insects and were not russeted. In this experiment no account was made of scabby fruit.

DISCUSSION OF RESULTS.

The results set forth in the above table are so self-evident that very little discussion is necessary. It will be seen that with regards insect control the three different insecticides produced almost exactly identical results. It may be said in this connection that not one of the apples classed as "wormy" was attacked by the codlin-moth but by the lesser apple worm. It will also be seen on comparing the per cents of sound fruit that the two substitutes produced even better results with regard to russetting than did the arsenate of lead paste, although these differences are probably within the limits of experimental error. So far as can be judged from the data obtained by this one experiment dry arsenate of lead and arsenate of zinc are fully as effective and are as safe to use as arsenate of lead paste. The results of the experiment, were on the whole so satisfactory, both with regards insect control and ease in mixing with the spray liquid, that dry arsenate of lead will be used on all the orchards at Highmoor Farm in 1913.