

UNIVERSITY OF MISSOURI

COLLEGE OF AGRICULTURE

Agricultural Experiment Station

BULLETIN NO. 124



Profits From Spraying Twenty-five Missouri Orchards in 1914

COLUMBIA, MISSOURI
January, 1915

UNIVERSITY OF MISSOURI

COLLEGE OF AGRICULTURE

Agricultural Experiment Station

BOARD OF CONTROL.

THE CURATORS OF THE UNIVERSITY OF MISSOURI.

EXECUTIVE BOARD OF THE UNIVERSITY.

THOMAS J. WORNALL, Chairman,
Liberty.

J. C. PARRISH,
Vandalia.

SAM SPARROW,
Kansas City.

ADVISORY COUNCIL.

THE MISSOURI STATE BOARD OF AGRICULTURE.

OFFICERS OF THE STATION.

THE PRESIDENT OF THE UNIVERSITY.

F. B. MUMFORD, M. S., Director, Animal Husbandry.

J. W. Connaway, D.V.S., M.D., Veterinary
Science.

Frederick Dunlap, F.E., Forestry.

C. H. Eckles, M.S., Dairy Husbandry.

C. E. Hutchinson, M.S.A., Farm Crops.

M. F. Miller, M.S.A., Soils.

G. M. Reed, Ph.D., Botany.

E. A. Trowbridge, B.S.A., Animal Hus-
bandry.

P. F. Trowbridge, Ph.D., Agricultural Chem-
istry.

J. C. Whitten, Ph.D., Horticulture.

H. O. Allison, M.S., Animal Husbandry.

H. L. Kempster, B.S.A., Poultry Hus-
bandry.

L. S. Backus, D.V.M., Veterinary Science.

P. M. Brandt, A.M., Assistant to Director.

J. B. Gingery, D.V.M., Veterinary Science.

Howard Hackendorf, B.S.A., Animal Hus-
bandry.

J. C. Hackleman, A.M., Farm Crops.

L. D. Haigh, Ph.D., Agricultural Chemistry.

Leonard Haseman, Ph.D., Entomology.

O. R. Johnson, A.M., Farm Management.

H. F. Major, B.S.A., Landscape Gardening.

E. M. McDonald, B.S., Farm Crops.

C. R. Moulton, Ph.D., Agricultural Chem-
istry.

L. S. Palmer, Ph.D., Dairy Chemistry.

E. C. Pegg, M.F., Forestry.

L. G. Rinkle, M.S.A., Dairy Husbandry.

L. A. Weaver, B.S.A., Animal Husbandry.

A. R. Evans, B.S.A., Assistant, Farm Crops.

W. E. Foard, A.M., Assistant, Farm Man-
agement.

R. R. Hudelson, B.S.A., Assistant, Soils.

E. H. Hughes, B.S.A., Assistant, Animal
Husbandry.

M. A. R. Kelley, B.S. in A.E., Assistant,
Farm Mechanics.

C. A. LeClair, A.M., Assistant, Soils.

T. C. Reed, A.M., Assistant, Dairy Hus-
bandry.

W. M. Regan, A.M., Assistant, Dairy Hus-
bandry.

C. C. Wiggans, A.M., Assistant, Horticul-
ture.

F. L. Bentley, B.S. in Agr., Assistant, Ani-
mal Husbandry.

C. E. Deardorff, B.S.A., Assistant, Soil
Survey.

A. J. Durant, B.S.A., Research Assistant,
Veterinary Science.

Carl Filler, B.S.A., Assistant, Veterinary
Science.

J. F. Hamilton, Assistant, Veterinary Sci-
ence.

H. C. Heaton, B.S.A., Assistant, Veterinary
Science.

F. Z. Hutton, (1) B.S.A., Assistant, Soil
Survey.

E. W. Knobel, B.S.A., Assistant, Soil Sur-
vey.

H. H. Krusekopf, B.S.A., Assistant, Soil
Survey.

C. E. Mangels, B.S.A., Assistant, Agricul-
tural Chemistry.

B. E. Sive, B.Ch.E., Assistant, Agricultural
Chemistry.

A. C. Stanton, B.S.A., Assistant, Dairy Hus-
bandry.

A. T. Sweet, (1) A.B., Assistant, Soil Survey.

Boleslaus Szymoniak, B.S.A., Assistant,
Horticulture.

W. E. Thrun, A.M., Assistant, Agricultural
Chemistry.

B. W. Tillman, (1) B.S.A., Assistant, Soil
Survey.

E. E. Vanatta, M.S.A., Assistant, Agricul-
tural Chemistry.

E. S. Vanatta, (1) B.S.A., Assistant, Soil
Survey.

C. A. Webster, B.S.A., Assistant, Poultry
Husbandry.

George Reeder, (1) Dir. Weather Bureau.

Etta O. Gilbert, (1) B.S.A., Seed Testing
Laboratory.

J. G. Babb, M.A., Secretary.

R. B. Price, B.S., Treasurer.

R. H. Gray, Accountant.

T. D. Stanford, Clerk.

Edith Briggs, Stenographer.

J. F. Barham, Photographer.

Arthur Rhys, Herdsman, Animal Husbandry.

C. M. Pollock, Herdsman, Dairy Husbandry.

(1) In the service of the U. S. Department of Agriculture.

TABLE OF CONTENTS

PLAN OF WORK	189
SPRAYING RESULTS SECURED IN 1913.....	191
SPRAYING RESULTS SECURED IN 1914.....	199
REVIEW OF SPRAYING RESULTS.....	265
COST OF SPRAYING.....	275
SUMMARY.....	284

FOREWORD

In figuring the quantity and value of the apples produced on sprayed and unsprayed plots for record in this bulletin, the figures in the case of a number of the orchards represent the results of actual sales of the crop where sales were made early.

A few of the orchardists held their fruit for later sale after the material in the bulletin was ready for the press. In the case of those orchards, the figures in the bulletin represent the actual quantity of fruit produced on sprayed and unsprayed portions of the orchards.

In some of these orchards where the fruit was held for later sale, the figures actually received for the crop fall below the figures recorded in the bulletin. This discrepancy in figures is due in one case to live stock destroying some of the fruit while it lay piled waiting for later sale. In other cases it is due to the fruit not keeping well without adequate cold storage.

J. C. WHITTEN
Horticulturist.

RESULTS OF CO-OPERATIVE SPRAYING EXPERIMENTS

W. L. HOWARD

During the seasons of 1913 and 1914 the University of Missouri sprayed or directed the spraying of twenty-nine co-operative orchards located in fourteen different counties of the state. This work was chiefly carried out under the authority of the forty-seventh General Assembly of Missouri which made a special appropriation of \$2500 for "orchard demonstration." Unfortunately the funds did not become available in time to apply to the spraying in the spring of 1913. What spraying was done that year was confined to one orchard near Columbia where the owner paid all of the expenses, and to four in Southwest Missouri where the Frisco Railroad and the orchardists met the expenses.

With the opening of the 1914 spraying season the funds became available and the scope of the work was greatly enlarged. During this season the spraying of twenty-five orchards was directed by representatives of the Horticultural and Entomological Departments. These orchards were located in the counties of Barry, Boone, Buchanan, Cape Girardeau, Clark, Clay, Cooper, DeKalb, Greene, Jackson, Laclede, Lafayette, Lawrence, and Marion. The Frisco Railroad again co-operated with the University by paying the traveling expenses (except train fares on the Frisco) of the men when it was necessary to visit the orchards at Lebanon, Willard, Republic, Monett, and Pierce City. Valuable assistance was rendered both years by Mr. Ashleigh P. Boles, Horticulturist of the Frisco Railroad.

PLAN OF WORK

In all cases the plan of spraying was co-operative. In all but four instances (two at Monett, one at McBaine, and one at Smithville) the University supplied the spraying chemicals and a spraying expert, while the orchard owners furnished the necessary spraying machinery, teams, and assistants. Two orchards near Monett were sprayed by the owners, the University and Frisco Railroad extending advisory assistance only. At Smithville a representative of the University visited the orchard and laid out a plan for doing the spraying. Following the directions given, the orchard owner did

the spraying himself without further assistance. The owner of the Turner Station orchard near McBaine paid all of the expenses of spraying including the chemicals, use of teams, labor and rental on the spraying outfit.

Throughout the entire spraying season as far as possible, every application of spray was made the occasion of a public demonstration. Upon being informed when a certain application was to be made, the owner of the orchard would notify his neighbors and ask them to attend the spraying demonstration. At these meetings the visitors not only looked on and asked questions but sometimes helped with the actual work of spraying. Sometimes a rural school or a class in agriculture from a nearby high school would attend a demonstration. On these occasions the man in charge of the demonstration always took time to explain why it is necessary to spray fruits, what materials are used for the different insects and diseases and how they are mixed and applied to the trees.

The demonstrations were undoubtedly productive of much good in the different communities. Those in attendance for the most part came for the purpose of securing exact information about how to spray apples, peaches, cherries, grapes, etc. The dates on which demonstrations were held were advertised by means of hand bills, by notices published in local papers, and by means of the rural telephone. The last method proved to be the best of all.

In counties where the University maintains a Farm Adviser, these gentlemen assisted in many ways. Mr. F. W. Faurot, Farm Adviser for Buchanan County, a recognized expert in spraying, helped both in the spraying and taking of notes in the two co-operative orchards in his county. Mr. E. A. Ikenberry, Farm Adviser for Jackson County, helped materially in handling the demonstrations in his county. Mr. C. M. McWilliams took an active interest in what spraying was done in Cape Girardeau, the county in which he is Farm Adviser. Mr. T. J. Talbert, Assistant in Entomology and Deputy Nursery Inspector had full charge of the dormant spraying against San Jose scale (which will be reported in full by the Department of Entomology) and also conducted many of the demonstrations in connection with the spring and summer spraying which was under the direction of the Department of Horticulture.

With the exception of two or three orchards all of the summer spraying was done with standard spraying materials of strengths that had been well tested in previous years. In every instance the spraying was done with whatever kind of machinery the orchard owner happened to have. In this connection it is interesting to

note that some of the best results were secured with the crudest or most inexpensive spraying outfits used.

WHAT TO SPRAY FOR

Apple orchards in Missouri must be sprayed every year against the apple scab disease, and also against the two insects, curculio and codling moth. Bordeaux mixture and lime sulphur solution (summer strength) are the standard remedies for the disease mentioned and for nearly all other diseases of the leaves and fruit. Arsenate of lead is used almost exclusively for poisoning curculio and codling moth and all other insects which bite or eat the leaves or fruit. Scale insects are controlled by spraying with a very strong solution of lime sulphur while the trees are in a dormant condition.

WHEN TO SPRAY

The first summer spray (the chief one for controlling scab) is given at the time when the clusters of flower buds have separated, but before the flowers themselves have unfolded or opened out. This is usually referred to as the "first spray," the "first scab spray," or the "cluster bud spray." The second application is made as soon as the petals of the flowers begin to fall. This is universally known as the "calyx spray," but sometimes referred to as the "second scab spray," or the "codling moth spray." This application is for the purpose of controlling the scab (for which either lime sulphur or Bordeaux mixture is used), and also the insects curculio and codling moth which are poisoned by adding arsenate of lead to the fungicide. A third and even a fourth application, at intervals of two or three weeks, may be necessary to control late outbreaks of scab and also such diseases as fly-speck or sooty blotch, black rot, cedar rust, apple blotch, Illinois canker, etc. Bitter rot may have to be combated late in the summer in the southern half of the state in some seasons. At the same time poison may be added as a protection against late broods of codling moth, curculio and lesser apple worm. Bitter rot sprayings may have to begin before the middle of July and continue, in extreme cases, until the middle of August or later. During the seasons of 1913 and 1914 bitter rot was not bad in Missouri.

SPRAYING RESULTS SECURED IN 1913

During the season of 1913 there was no outbreak of bitter rot or other highly destructive fungous disease. Apple scab, however, was very prevalent in the southwestern part of the state and the

curculio in that section were exceedingly numerous. Codling moth were equally abundant. Five orchards only were sprayed: The Lebanon Orchard Company and the McFadden Orchard at Lebanon; two at Pierce City belonging to C. D. Peck and G. V. Kline; and one, the Turner Station Orchard, near McBaine. The results follow.

The Lebanon Orchard Company Orchard (Lebanon, Laclede County). A block of Ben Davis trees about 20 years old, were sprayed three times. The first or "cluster spray" was given April 18, using lime sulphur, 3 gallons to one hundred gallons of water. The second or "calyx spray" was given on May 3 with lime sulphur 3 to 100 and arsenate of lead 6 pounds to each 100 gallons of spray mixture. The third application, the same as the second, was made on May 17.

There was a light bloom and a very small setting of fruit in this orchard. The amount of fruit on the trees was not sufficient to justify three thorough sprayings. They were given for the benefit of the trees themselves rather than for the fruit, as this orchard had never been sprayed before.

About May 25 there was a severe hailstorm which destroyed what few apples there were before any notes were taken. The foliage of the sprayed trees had a fine healthy color all summer and in late summer, in August, it was observed that the leaves on the unsprayed trees began to fall. By September these trees were almost entirely bare while the sprayed ones remained green until overtaken by frost a month or more later.

The McFadden Orchard (Lebanon, Laclede County). In this orchard a block of Jonathan trees about fifteen years old was sprayed April 13, May 3, and May 16. The first application was with lime sulphur 3 to 100; the second with lime sulphur 3 to 100 and 5 pounds of arsenate of lead paste; and the third with Bordeaux mixture 4-6-100 (4 pounds copper sulphate, 6 pounds lime and 100 gallons water) and 5 pounds arsenate of lead.

There was a splendid crop of fruit in prospect but a terrific hailstorm about May 25 literally beat the apples to pieces. The sprayed fruit was free from scab and had suffered but little insect injury up to the time of the storm. The adjacent unsprayed trees showed scab and a great deal of curculio and codling moth injury. Shortly after the storm it was observed that codling moth began to attack the sprayed apples, the worms entering the fruit in each case through the wounds made by the hail stones.

As all of the apples were ruined by the hail no notes were taken, the experiment being abandoned. However, it was very noticeable

that the spraying benefited the foliage as the sprayed trees held their leaves in fall much longer than those that were not sprayed.

The G. V. Kline Orchard (Pierce City, Lawrence County). In this orchard a block of fifty Jonathan trees nine or ten years old was set apart for the demonstration work. Forty of the trees were sprayed and ten left unsprayed to check the results. The trees were sprayed four times as follows:

April 14, with Bordeaux 6-6-100.

May 2, with Bordeaux 3-6-100 plus 6 lbs. arsenate of lead.

May 15, with Bordeaux 4-6-100 plus 5 lbs. arsenate of lead.

June 25, with Bordeaux 8-8-100 plus 5 lbs. arsenate of lead.

There was a good bloom but pollination was imperfect so that after the "June drop" was over the crop was very light.

The previous season (1912) no spraying was done and curculio were very numerous. While the orchard was cultivated both in 1912 and 1913 there was meadow land adjoining and an old sod orchard, which had not been kept pruned or sprayed, was near by.

At the time the third spraying was done, May 15, it was evident that we were about three days too late as the curculio had already begun to work on a large scale. This accounts for the large percentage of the fruit injured from this insect. Incidentally too, this illustrates one of the difficulties of trying to manage an orchard at a distance. To obtain best results one should see the orchard every day during the spraying season.

On June 25, after the "June drop" was over, the first notes were taken. At this time very few apples were left on the trees. Representative trees were selected and every apple on each carefully examined for disease and insect injury. On the sprayed trees the fruit showed 33 per cent curculio injury while on the check (unsprayed) trees there was 78 per cent. The sprayed fruit showed no injury from worms (codling moth), while on the unsprayed 40 per cent was wormy. There was only a trace of scab and that was on the unsprayed trees.

The small amount of fruit that matured was harvested September 30. The results follow: Marketable fruit, from sprayed trees, 85 per cent; unsprayed, 16 per cent. The value of the crop at current prices was, sprayed \$19.68 per acre; unsprayed, \$1.80 per acre. The cost of spraying amounted to \$12 per acre, leaving a net profit due to spraying of \$7.68 per acre.

The above results cause one fact to stand out clearly and that is that it pays to spray even when only a very small crop of fruit is in prospect.

The C. D. Peck Orchard (Pierce City, Lawrence County). This orchard consisted of the following varieties: Missouri (Pippin),

Arkansas (Mammoth Black Twig), York (Imperial), Gano and Ben Davis. The trees were about 20 years old. The orchard was partially in grass. Some plowing in spring had been done between the rows. The trees were sprayed four times as follows:

April 14, with lime sulphur 3-100.

May 1, with lime sulphur 3-100 plus 6 lbs. arsenate of lead.

May 15, with Bordeaux 4-6-100 plus 5 lbs. arsenate of lead.

June 25, with Bordeaux 8-8-100 plus 5 lbs. arsenate of lead.

The bloom was very heavy on all trees except the Ben Davis and Gano. Just after the second spraying twig blight appeared which swept away practically all of the fruiting spurs on the York trees. Over half the spurs were killed on the Arkansas trees and on the Missouri, where the bloom was exceedingly heavy, more than 50 per cent were destroyed but enough were left to permit of a heavy crop of fruit.

This orchard of about four acres was planted in long rows, one variety to a row. This made it convenient to spray a large block of trees and leave a block on one end unsprayed to check the results. All of the spraying was done with a barrel outfit, the barrel being mounted on an improvised one-horse wagon with a tower over the barrel where the man with the rod stood in order to be able to reach the tops of the rather large trees. One man worked the pump and drove the horse.

On May 14 it was observed that there were some signs of scab on the leaves of the unsprayed trees, the sprayed trees being clean. There were fully 10 per cent of curculio stings on the unsprayed and none on the sprayed trees.

On May 28 the unsprayed trees showed the following: Ben Davis, leaves scabby (almost no fruit); Gano, fruit scarce but 50 per cent injured by both scab and curculio; York, practically no fruit, some scab and curculio; Arkansas, leaves scabby, 80 to 90 per cent of fruit injured by scab and curculio; Missouri, leaves showed trace of scab, while 25 to 30 per cent of the fruit was injured by scab and curculio.

On June 25, after the "June drop" was over the apples on the sprayed and unsprayed trees were carefully examined for disease and insect injury. The results are summarized below.

Total insect injury	$\left\{ \begin{array}{l} \text{Sprayed fruit } 20.4 \text{ per cent} \\ \text{Unsprayed fruit } 65.3 \text{ per cent} \end{array} \right.$
---------------------	---

Total disease injury	$\left\{ \begin{array}{l} \text{Sprayed fruit } 3.1 \text{ per cent} \\ \text{Unsprayed fruit } 62.8 \text{ per cent} \end{array} \right.$
----------------------	--

It should be explained that in the above statements many apples were counted twice as a result of being affected with both diseases and insects.

The outbreak of curculio was unusually severe in the spring of 1913. Here, as at the Kline orchard, the third spraying was done about three days too late to control these insects. While the curculio were very bad many of the apples punctured by them were so slightly wounded that their subsequent growth and final sale value were not seriously affected.

The net results (up to June 25) of the spraying on the two varieties, Arkansas (Mammoth Black Twig) and Missouri (Pippin), that bore a crop were as follows:

Total clean fruit (free from both diseases and insects)	{	Sprayed 81.9 per cent	Unsprayed 2.8 per cent
---	---	----------------------------	-----------------------------

The apples were harvested and final notes taken on October 16. The Arkansas (Mammoth Black Twig) and Missouri (Pippin) were the only varieties with yield large enough to gather for note taking purposes. The fruit on the others was destroyed by twig blight early in the spring.

At the time the last summer notes were taken (June 25) about one-fourth of the fruit on the unsprayed Missouri and Arkansas trees was wormy—that is, was affected with codling moth. Only 2 to 7 per cent of the sprayed fruit of these varieties was wormy at the same time. Practically all of the apples that became wormy that early in the season soon fell off. On this account the final figures at harvesting time are not given in terms of insect injury because this would not show the true effects of the spraying. Instead, the apples were sorted into three grades according to the extent of their injury from both diseases and insects. The first grade consisted of fruit practically free from blemishes of all kinds, sound, well-shaped, well colored and more than two and one-half inches in diameter. The second grade consisted of fruit with slight blemishes, somewhat off color and undersized, but not less than two and one-quarter inches in diameter. The third grade consisted of culls or apples unfit for barreling. The grading results were as follows:

Sprayed, Arkansas, 69 per cent were of commercial grade.

Unsprayed, Arkansas, 31 per cent were of commercial grade.

Sprayed, Missouri, 94 per cent were of commercial grade.

Unsprayed, Missouri, 18 per cent were of commercial grade.

There were very few of the unsprayed apples and none good enough to go in the first grade class.

Reduced to an acre and dollar basis, the value of the crop at current prices was as follows:

Arkansas, sprayed, total income	\$164.75 per acre
Arkansas, unsprayed, total income.....	2.90 per acre
Cost of spraying four times,.....	16.00 per acre
Net income from sprayed trees.....	148.75 per acre
Income from unsprayed trees.....	2.90 per acre
Net profit due to spraying.....	145.85 per acre
Missouri, sprayed, total income.....	\$202.20 per acre
Missouri, unsprayed, total income.....	9.80 per acre
Cost of spraying four times.....	16.00 per acre
Net income from sprayed trees.....	186.20 per acre
Income from unsprayed trees.....	9.80 per acre
Net profit due to spraying.....	176.40 per acre

The above figures from the Peck orchard show in conclusive manner that spraying pays big dividends, in this case from 900 to 1100 per cent.

The Turner Station Orchard (Near McBaine, Boone County). This orchard consisted of four varieties—Jonathan, York, Gano and Winesap. The spraying materials used were chiefly Bordeaux and arsenate of lead paste. Lime sulphur and also arsenate of lead powder were used to a small extent in an experimental way. Briefly, 3 pounds of the powdered lead gave approximately the same results as 6 pounds of the paste with the Jonathan, but slightly better results than the paste with the York. In this case the difference in favor of the powder (a little less than 3 per cent) is scarcely outside of the range of experimental error.

This co-operative spraying test was an important one because it was conducted on a large scale and further because all of the figures are available covering every item of the work of spraying and also how the apples graded at harvest time and the cash returns actually secured for the crop. The total area sprayed was: Jonathan, 10 acres, York, 6 acres, Gano and Winesap only a few trees each. Two applications were made, one beginning on April 19 and the other beginning on May 2. The entire orchard consisted of 23 acres and the first spraying covered this area. Owing to engine troubles the work of spraying the first time occupied five days. The solution used was Bordeaux 4-6-100, no arsenate of lead being used.

The second application (the calyx spray) occupied seven and three-fourths days. Since only a few of the Gano trees bloomed, these alone were sprayed at this time which reduced the total area sprayed to about 17 acres. It may be added that the final area which set a crop of fruit was, Jonathan, 8 acres; York, 2 acres;

Gano, 12 trees; Winesap, 7 trees, or a total of a little more than 10 acres.

The long time ($7\frac{3}{4}$ days) required for spraying the second time was due to engine troubles and to a scarcity of water. Much of the water had to be hauled a long distance over improvised roads.

It was not necessary to leave any of the trees unsprayed as there was a 20-acre orchard of practically the same age, the same varieties (Jonathan, 12 acres, Gano, 8 acres) on precisely the same kind of soil, on an adjoining farm, and this orchard was not sprayed.

Below is given a summary of the cost of spraying the Turner Station orchard twice:

First application, Bordeaux 4-6-100.

Labor, 2 men and team 5 days, and rent on sprayer....	\$29.30
Spraying materials and gasoline.....	13.58

Total.....	\$42.88
------------	---------

Second application, Bordeaux 3-5-100 and 6 lbs. arsenate of lead.	
--	--

Labor, team and rent on outfit, $7\frac{3}{4}$ days.....	\$49.00
Spraying materials and gasoline.....	33.51

Total.....	\$82.51
------------	---------

Total for two applications.....	\$124.39
---------------------------------	----------

The following observations were made on June 17 after the "June drop" was over:

Total insect injury	{ Sprayed fruit, 19.0 per cent Unsprayed fruit, 57.9 per cent
---------------------	--

In securing the above figures a total of 4557 apples were counted on the sprayed trees and 1753 on the unsprayed trees.

At harvest time on September 11, 1913, representative trees were selected and the apples counted and graded. The results follow:

Total insect injury	{ Sprayed fruit, 23.17 per cent Unsprayed fruit, 68.31 per cent
---------------------	--

There was no disease injury on any of the trees in either orchard.

Curculio were very numerous this season and difficult to control. On two sides of the sprayed orchard was wild woodland. Also the orchard was in clover and blue grass. There was woodland only at one corner of the unsprayed orchard. Practically the whole of the unsprayed orchard was cultivated in spring and planted to corn. The latter, however, made but small growth on account of the severe drought.

The following is a record of the yield and cash returns for the two orchards.

SPRAYED ORCHARD

Jonathan, 8 acres.

41 barrels	No. 1 apples at \$4.15.....	\$170.15
51 barrels	No. 2 apples at 3.67.....	187.17
97 barrels	windfalls at 1.31.....	127.07

York, 2 acres.

41 barrels	No. 1 apples at \$3.25.....	\$133.25
22 barrels	No. 2 apples at 2.75.....	60.50
28 barrels	windfalls at 1.40.....	39.20

Winesap, 7 trees.

3 barrels	No. 1 apples at \$3.25.....	\$ 9.75
1 barrel	No. 2 apples at 2.75.....	2.75

Gano, 12 trees.

2 barrels	No. 1 apples at \$3.00.....	\$ 6.00
1 barrel	No. 2 apples at 2.50.....	\$ 2.50

Total income from entire apple crop.....	\$738.34
Cost of spraying twice.....	124.39

Net returns from sprayed orchard.....	\$613.95
Average net returns per acre from sprayed orchard.....	\$ 59.89

UNSPRAYED ORCHARD

Jonathan, 8 acres bearing; Gano only a few trees bearing.

Total income from unsprayed orchard.....	\$ 23.00
Average net profits per acre from unsprayed orchard.....	2.78
Net profits per acre due to spraying.....	57.65

The large quantity of windfalls in the sprayed orchard was caused by a windstorm just before harvesting time. A severe hailstorm in August disfigured much of the fruit so that in grading an undue proportion had to go in the No. 2 class. Also the season was very warm and dry. As a consequence the fruit was smaller than normal. The warm weather continued up until harvesting time without even any cool nights. On this account the apples became ripe and had to be picked, beginning September 9, although at that time they were far from being red. Poor size and color contributed heavily to the No. 2 grade.

In conclusion it may be added that the sprayed orchard reported upon was the only one in that part of the state that bore anything like a full crop or even half a crop in 1913.

SPRAYING RESULTS SECURED IN 1914

The season of 1914, on the whole, was favorable to the fruit grower. As is the case nearly every year, there were certain districts where diseases or insects or both were more abundant than elsewhere. There was less apple scab than usual although there were places where the percentage of this disease ran very high on unsprayed trees. Bitter rot, which sometimes becomes epidemic in the southern half of the state, was very scarce. Only now and then was it reported during the season and then only on varieties like Huntsman and Willow (Twig) which are particularly susceptible to the disease. Two diseases which are rarely heard of north of the Missouri River were very prevalent all over the state this year. These were the cedar rust and black or blossom end rot. Twig blight appeared again toward the close of the blooming period but did much less harm than the year before. In 1913 the blight attacked the fruit spurs and killed every flower in the various clusters. In 1914 the infections again started in the spurs but only a few of the flowers were killed. As a rule the spurs themselves did not perish. This year many of the new twigs at the ends of the long branches were attacked and killed back for from four or five inches to a foot, but this caused little damage as no flowers were involved.

The two insects which always have to be fought every year—curculio and codling moth—were present in all parts of the state. The dry weather which prevailed from May until August greatly favored the spread of the codling moth. Another insect, the lesser apple worm or side worm, was especially bad in 1914. This insect bores a hole into the apples starting at almost any point on the surface but usually on the side. If the "worm" penetrates deep it goes straight into the fruit in whatever direction it may start. In such cases the hole it leaves is much smaller than that made by the codling moth. Sometimes though, the side worm penetrates only a quarter or half an inch and then burrows out quite a large cavity. Again burrows may be made along near the surface, sometimes just through the skin or a little deeper. This is the way the insect works on the fruit in cellar storage and sometimes even in cold storage if the temperature is not kept constantly around the freezing point.

In 1914 the spraying was again done with whatever kind of outfit the orchard owner might have. As a rule only standard spraying

solutions of the usual strengths were used. The cost of the spraying was computed by charging 12½ cents per gallon for lime sulphur, 10 cents per pound for arsenate of lead paste, 20 cents per pound for arsenate of lead powder, 6 cents per pound for copper sulphate and one cent per pound for fresh stone lime. Labor was charged at the rate of \$1.50 per day for men and \$1.50 per day for teams. The idea kept in view was to compute the cost of the spraying on a basis that would be comparable to what the average farmer or fruit grower would have to pay for materials and help. If the farmer uses his own teams and does his own work the cash outlay for these items could be eliminated. Also if spraying materials are bought in large quantities much better figures than the ones mentioned could be secured. In some instances arsenate of lead was actually secured by some co-operators for as low as 6 cents per pound. On the other hand where the materials were bought in small quantities from a local druggist the cost was as much as 13½ cents per pound for the lead and 35 cents per gallon for the lime sulphur.

The records of the different orchards together with summaries, comparisons, etc., are as follows.

The Bland Orchard Co. Orchard (Lebanon, Laclede County). The experimental plot consisted of a block of Ben Davis trees about 20 to 25 years old. No cultivation had been given for two years but the trees were in a fair state of vigor. Thirty-six trees were sprayed. The applications were as follows:

April 17, with lime sulphur, 4-100.

May 6, with lime sulphur, 3-100 plus 6 lbs. arsenate of lead.

May 26, with lime sulphur 3-100 plus 4 lbs. arsenate of lead.

Notes were taken in summer after the "June drop" was over which showed the following results up to July 3d.

Sprayed trees, sound fruit.....93.2 per cent

Unsprayed trees, sound fruit.....5.2 per cent

The greatest amount of injury from a single cause was from scab. On the unsprayed trees 84.3 per cent of the fruit was affected with this disease. The black or blossom end rot attacked 22 per cent of the fruit on the same trees. On the sprayed trees there was 4.3 per cent of scab but only a trace of rot and insect injury.

The figures in Table I show the results in detail.

The results show that the rather severe outbreak of apple scab was effectively controlled. The rot mentioned was black rot or, as it is more commonly known, blossom end rot. This is usually very difficult to hold in check by spraying but the figures show that the three applications of lime sulphur, in this instance, reduced the rot

Table 1.—Results of Spraying in Bland Orchard up to July 3, 1914

Variety	Treatment	Percentage insect, disease and spray injury						Percentage of sound, unblemished fruit
		Worms	Curculio	Scab	Cedar Rust	Rots	Spray Injury (Russet- ing)	
Ben Davis	Sprayed	0.6	0.5	4.3	0	0.6	1.3	91.9
	Check, unsprayed	5.2	2.5	84.3	0	22.0	....	5.2

Table 2.—Harvesting Data in Bland Orchard at Lebanon

Variety	Treatment	Percentage of insect, disease and spray injury						Marketable fruit per tree	Value of fruit per acre
		Worms	Curculio	Scab	Rots	Cedar rust	Spray injury		
Ben Davis	Sprayed	12.2	10.0	21.2	18.3	0.8	12.6	$\frac{3}{4}$ bu. No. 1 $1\frac{1}{4}$ bu. No. 2 $\frac{3}{8}$ bu. culls	\$47.70
	Check, unsprayed	29.0	30.1	78.0	40.0	0.0	....	$\frac{5}{8}$ bu. culls	\$5.40

injury to a bare trace. Codling moth (worms) and curculio were also held in check.

When codling moths attack apples before the latter are half grown, a large percentage fall off. Diseased apples may also drop long before harvesting time. This will explain why harvesting data may show a smaller percentage of injury from these causes than notes taken in early summer.

In July the lesser apple worm (more popularly known as the side worm) began to be noticeable in apple orchards all over the state. Since their work looks very much like that of the codling moth when the latter attacks the side of an apple, both of these insects are, for convenience, classed together under the heading of "worms."

The fruit in the demonstration plot of the Bland orchard was harvested in October and careful counts made from sprayed and unsprayed trees. The results of the spraying at harvesting time are given in Table 2.

The cost of spraying this orchard three times was as follows, per tree: Materials, 20 cents; labor $8\frac{1}{2}$ cents; total $28\frac{1}{2}$ cents, or \$17.10 per acre. The profits due to spraying were \$25.20 per acre.

The H. S. Branaman Orchard (Near Armour Station, Buchanan County, Postoffice Rushville). This orchard was located in the fertile soil of the Missouri river bottom. The trees were large for their age, about 17 or 18 years old, and for the most part were in a thrifty state of growth. The demonstration plat consisted of about 100 trees, the varieties being Ben Davis and Winesap. They were sprayed as follows:

April 21, with lime sulphur 4-100.

May 5-6, with lime sulphur 6-100 plus 4 lbs. arsenate of lead.

May 28, with lime sulphur 6-100 plus 5 lbs. arsenate of lead.

July 7, with lime sulphur 6-100 plus 6 lbs. arsenate of lead.

The spraying machine used was a Bean Duplex power outfit. Summer notes were taken on June 17 after the "June drop" was over. The results are tabulated in Table 3.

While the spraying controlled the codling moth almost absolutely and diseases were not present on account of the dry weather, there was an outbreak of curculio which occurred too late to be hindered by the second application and too early to be poisoned by the third application. This accounts for the large percentage of injury from this insect on the sprayed trees. However, it will be noticed that in the case of Ben Davis the curculio injury on the sprayed trees was 21 per cent while on the unsprayed trees it was 78 per cent. This would show that it was only those insects that appeared late that

Table 3.—Results of Spraying in Branaman Orchard up to June 17, 1914

Variety	Treatment	Percentage insect, disease and spray injury						Percentage of sound, unblemished fruit
		Worms	Curculio	Scab	Cedar Rust	Rots	Spray Injury (Russet- ing)	
Ben Davis	Sprayed	0.8	21.7	0	0	0	0.75	76.5
	Check, unsprayed	85.2	78.9	0.3	0	0	....	2.3
Winesap	Sprayed	0	8.7	0	0	0	1.1	90.3
	Check, unsprayed	49.6	29.0	2.0	0	0	....	32.0

were able to do much injury. On June 17 there was only 2.3 per cent of sound fruit on the unsprayed Ben Davis trees while on the unsprayed Winesap there was 32 per cent. Since much of this injury was due to the attacks of codling moth, it would be expected that the second brood would very likely spread to the remainder of the apples on these trees.

The fruit was harvested in October and by means of counting thousands of apples, a careful record was made up showing final results of spraying. These are shown in Table 4.

The cost of spraying four times was as follows, per tree: Materials, 31 cents; labor 20 cents; total, 51 cents, or \$30.60 per acre. The profits due to spraying in case of the Ben Davis were \$467.40 per acre; Winesap \$406.20 per acre. These figures seem very remarkable but those who are familiar with the profits from spraying, particularly in an orchard that has not been sprayed before, in a good crop year, will not be surprised at these results.

The D. E. Brite Orchard (Near Pierce City, Lawrence County, Postoffice Monett). This was one of the advisory orchards. All of the spraying was done by the owner who merely followed the advice given him by the University of Missouri and the Horticulturist of the Frisco. The owner supplied all of the labor and materials and did all of the work. The orchard was sprayed three times, twice with Bordeaux mixture and arsenate of lead and once with soluble sulphur and arsenate of lead. The trees were 15 years old and while they had been badly neglected were still in fairly vigorous condition. No summer notes are available. The harvesting data are shown in Table 5.

The figures in the table show that the crop on the unsprayed trees was practically destroyed by apple scab. It should be remembered that the owner of this orchard had had very little experience in spraying so that the results are very gratifying. While one should be able to control the scab almost entirely by thorough spraying, the difference between 16.8 per cent and 93.9 per cent is 77.1 per cent which is a good record in controlling this disease. The large percentage of spray injury shown was mostly due to arsenic burning from the soluble sulphur spray. The cost of spraying was 19.2 cents per tree for the season or \$11.52 per acre. This would show a profit due to spraying of \$44.28 per acre.

The J. G. Dameron Orchard (Near Hannibal, Mo.). This orchard consisted of Jonathan and Ben Davis trees. The sprayed plat included both of these varieties. The trees were 15 years old and had received fairly good pruning the previous year. The orchard was in blue grass sod. The trees were sprayed as follows:

Table 4—Harvesting Data in Branaman Orchard, Armour, Mo.

Variety	Treatment	Percentage insect, disease and spray injury						Marketable fruit per tree	Value of fruit per acre
		Worms	Cur-culio	Scab	Rots	Cedar rust	Spray injury		
Ben Davis	Sprayed	8.2	7.4	0	0	0	0	13.8 bu. Nos. 1 and 2 2.1 bu. culls	\$507.00
	Check, unsprayed	100	96.0	0	0	0	...	$\frac{1}{2}$ bu. culls	\$ 9.00
Winesap	Sprayed	7.1	42.1	0	0	0	0	10 bu. Nos. 1 and 2 $2\frac{1}{2}$ bu. culls	\$487.20
	Check, unsprayed	88.9	98.2	0	0	0	...	$\frac{1}{4}$ bu. No. 2 4.7 bu. culls	\$ 50.40

Table 5—Harvesting Data in the Brite Orchard, Monett

Variety	Treatment	Percentage insect, disease and spray injury						Marketable fruit per tree	Value of fruit per acre
		Worms	Curculio	Scab	Rots	Cedar rust	Spray injury		
Ben Davis	Sprayed	1.2	2.6	16.8	0.5	0	62.7	1.3 bu. No. 1 $\frac{1}{3}$ bu. culls	\$ 55.80
	Check, unsprayed	19.2	4.5	93.9	7.5	0	...	1 bu. culls	0

April 22 with lime sulphur 3-100.

May 11 with lime sulphur 3-100 plus 6 lbs. arsenate of lead.

There were thirty-six trees in the sprayed plat. All trees received an application of lime sulphur of a strength of 1-7 on March 28 for the purpose of controlling the San Jose scale which was present. The first notes were taken July 2. The results of the summer spraying are given below. Data on dormant spraying not taken.

No notes are available showing results of spraying on the Jonathan variety.

It should be remembered that this orchard was sprayed only twice and that two applications rarely afford adequate protection against insects and diseases which are likely to be prevalent in late May and June.

The fruit was harvested in October and the apples on representative trees counted. The results are given in Table 7.

The data show that this orchard should have been sprayed a third time. The failure to make the third application accounts for the large percentage of insect injury shown on the sprayed trees.

The cost of spraying for the two applications per tree was as follows: materials, 11 cents; labor, 14 cents; total, 25 cents, or \$15.00 per acre. This represents a profit due to spraying amounting to \$60.10 per acre. It should be added that had a third application been made there would have been a much higher percentage of No. 1 fruit. While much of the No. 2 fruit was salable it was of a low grade and hence not nearly so valuable as the better grade.

The G. W. Davis Orchard (Near Independence, Jackson County). This was a small commercial orchard consisting of 7 or 8 acres of trees, mostly Ben Davis. The trees were 18 or 20 years old and in a reasonably vigorous condition. The soil was fertile but the orchard had not been cultivated recently. Only a slight amount of pruning had been done.

The kind of sprayer used was a Bean hand power outfit, the pump being mounted on a tank holding 150 gallons. The pump was worked by two men. Even then with only one lead of hose it was not possible to hold the pressure, on the average, above 100 pounds. This answered very well for the first or cluster bud application, but when using the Bordeaux nozzle for the calyx spray where the discharge was much greater than during the first application, the pressure was found to be insufficient to spray the flower clusters properly in the tops of the trees. Twelve large trees made up the experimental plat. These trees were sprayed as follows:

April 20, with lime sulphur 3-100.

May 5, with lime sulphur 3-100 plus 6 lbs. arsenate of lead.

Table 6.—Results of Spraying in Dameron Orchard up to July 2, 1914

Variety	Treatment	Percentage insect, disease and spray injury						Percentage of sound, unblemished fruit
		Worms	Curculio	Scab	Cedar Rust	Rots	Spray Injury (Russet- ing)	
Ben Davis	Sprayed	2.5	2.5	0	0	0	0	94.8
	Check, unsprayed	17.5	72.1	1.7	0	0	....	10.0

Table 7—Harvesting Data in Dameron Orchard, Near Hannibal

Variety	Treatment	Percentage insect, disease and spray injury						Marketable fruit per tree	Value of fruit per acre
		Worms	Curculio	Scab	Rots	Cedar rust	Spray injury		
Ben Davis	Sprayed	18.5	34.4	0	3.7	0	0	1½ bu. No. 1 3½ bu. No. 2 1¾ bu. culls	\$121.80
	Check, unsprayed	39.1	21.7	0	20.0	0	...	¼ bu. No. 2 4¾ bu. culls	\$ 44.70

May 27, with lime sulphur, 2-100 plus 4 lbs. arsenate of lead.

The first notes on the spraying were taken on June 16. The results are tabulated in Table 8.

The figures in the table show that the spraying practically controlled both diseases and insects. While there was a slight amount of spray injury, this was not at all serious as a small amount of russetting will easily be obscured when apples have attained their color.

In October the fruit from the experimental trees was harvested and the apples carefully counted. The results are shown in Table 9.

In addition to the statistics in the table, it should be added that another disease, apple blotch, was present in the orchard. There was 7.3 per cent of this disease found on the fruit of the sprayed trees, and 30 per cent on the unsprayed trees.

The cost of the spraying was as follows per tree: Materials, 27 cents; labor, 25 cents; total, 52 cents, or \$31.62 per acre. The profits due to spraying amounted to \$369.78 per acre.

This orchard had never been sprayed before and hence in an average season the majority of the fruit was almost sure to be destroyed by insects and diseases. The seemingly large profits from the spraying were due to this cause. In an orchard that is sprayed regularly the difference between sprayed and unsprayed trees in any one season probably would not be particularly great, as the effects of spraying are cumulative and last more than one season. Of course this is due to the increased vigor of the sprayed trees and also to the fact that where insects and diseases are kept in control for several seasons, they will not suddenly become abundant if a few sprayings are omitted.

The E. H. Dienst Orchard (Alexandria, Clark County). This was one of the advisory orchards. The owner was desirous of learning how to spray for scale. A representative of the University visited the orchard and gave full directions for preparing lime sulphur to be used as a dormant spray.

A full report on this co-operative orchard will be published from the Department of Entomology, as this bulletin is concerned only with summer spraying.

The Greenwade Orchard (Near Willard, Greene County). This orchard was located on level prairie land, the soil being clay loam and fairly fertile. The trees were about 25 years of age and rather low in vigor. San Jose scale was present, and several trees were affected with cankers. A block consisting of 70 trees of Ben Davis was set apart for the spraying experiment. A power sprayer was used. The following applications were given:

Table 8.—Results of Spraying in Davis Orchard up to June 16, 1914

Variety	Treatment	Percentage insect, disease and spray injury						Percentage of sound, unblemished fruit
		Worms	Curculio	Scab	Cedar Rust	Rots	Spray Injury (Russet- ing)	
Ben Davis	Sprayed	0.3	3.5	0.6	0	0	5.0	90.8
	Check, unsprayed	11.0	16.5	11.0	0	0	....	62.6

Table 9—Harvesting Data in Davis Orchard Near Independence

Variety	Treatment	Percentage insect, disease and spray injury						Marketable fruit per tree	Value of fruit per acre
		Worms	Curculio	Scab	Rots	Cedar rust	Spray injury		
Ben Davis	Sprayed	5.5	21.3	.04	0	0	0	$\frac{1}{2}$ bu. No. 1 4 bu. No. 2 3 bu. culls	\$434.46
	Check, unsprayed	60.6	20.4	1.8	0	0	...	$\frac{1}{2}$ bu. No. 1 $\frac{3}{8}$ bu. No. 2 $1\frac{1}{8}$ bu. culls	\$ 33.00

April 4, with lime sulphur 3-100, plus 5 lbs. arsenate of lead.
May 5, with lime sulphur 5-100, plus 6 lbs. arsenate of lead.
May 25, with lime sulphur 2-100, plus 5 lbs. arsenate of lead.
July 2, one-half with Bordeaux mixture 8-8-100, plus 5
lbs. arsenate of lead; one-half with lime sulphur 3-100,
plus 5 lbs. arsenate of lead.

The owner sprayed the orchard the first time, this being the important application for controlling the scab. The fourth application with both the Bordeaux and the lime sulphur was also given by the owner of the orchard. No summer notes were taken. The apples from several representative trees that were sprayed and unsprayed were harvested in October and counted. The results are given in Table 10.

The striking feature of the results is the high percentage of scab on the sprayed fruit. Evidently the first application, the one that chiefly protects against scab, was not thoroughly made. Insects were controlled within reasonable limits. Just why the insect injury should be greater on the sprayed trees than on the unsprayed, is not clear. The fourth spraying seems to have afforded nearly complete protection against the blossom end rot.

The cost of spraying per tree was as follows: Materials, 20.5 cents; labor, 10.9 cents; total, 31 cents, or \$18.84 per acre. Profits due to spraying were \$104.66 per acre.

The Dr. M. S. Henderson Orchard (Jackson, Cape Girardeau County). This was one of the advisory orchards. Through the co-operation of Mr. C. M. McWilliams, County Farm Adviser for Cape Girardeau County, the above orchard was sprayed against San Jose scale. The results of the spraying will be reported by the Department of Entomology.

The Lester Hostetter Orchard (Near Weatherby, DeKalb County). This was a small home orchard consisting for the most part, of very large, old trees growing in sod. The trees were sprayed twice with a barrel outfit which was wholly inadequate as the trees were much too large, and the pressure much too low to do thorough work. In both applications the spraying material ran short so that the trees were not well covered. The applications were given as follows:

April 24, with lime sulphur 3-100.

May 8, with lime sulphur 3-100, plus 4 lbs. arsenate of lead.

Unfortunately no notes are available showing the exact results of the spraying. However, the owner noticed that the fruit was cleaner where the trees had been partially sprayed. The foliage on

Table 10—Harvesting Data in Greenwade Orchard at Willard

Variety	Treatment	Percentage insect, disease and spray injury						Marketable fruit per tree	Value of fruit per acre
		Worms	Curculio	Scab	Rots	Cedar rust	Spray injury		
Ben Davis	Sprayed	4.0	3.1	45.7	1.4	0	0	1½ bu. No. 1 3½ bu. No. 2 1 bu. culls	\$130.40
	Check, unsprayed	1.1	1.9	77.0	15.8	0	...	½ bu. No. 2 ½ bu. culls	\$ 6.90

the sprayed trees also remained on the trees much later in the fall than where no spraying was done.

The Roy Jackson Orchard (Republic, Greene County). This orchard was about 25 years old and being in fertile soil the trees were in a vigorous condition and quite large. The variety was Ben Davis. Forty-seven trees were included in the demonstration plat. The spraying was done with a Friend power sprayer, using three leads of hose and carrying 250 lbs. pressure. The applications were made as follows:

- April 10, with lime sulphur 3-100, plus 2 lbs. powdered arsenate of lead.
- May 4, with lime sulphur 3-100, plus 6 lbs. arsenate of lead paste.
- May 23, with lime sulphur 2-100, plus 2 lbs. powdered arsenate of lead.
- June 30, with Bordeaux mixture 8-8-50, plus 2½ lbs. powdered arsenate of lead.

The orchard was growing in sod and not much pruning had been done except to remove lower branches. The tops of the trees were rather dense, making it difficult to reach all parts with the spray material. The first notes were taken on June 30 after the "June drop" was over. For results see Table 11.

The results of the spraying as regards protection from both diseases and insects were very gratifying. While the insects were not very numerous on the unsprayed trees there was over 81 per cent of scab injury, which indicates that very little, if any of the fruit on these trees is likely to be of first grade at harvesting time. While there was a rather high percentage of russetting due to cold weather in April, this need not necessarily spoil the sale value of the fruit after the apples have attained their color.

The apples were harvested on October 12th. All of the apples on certain representative trees were counted and classified according to size, freedom from blemish, etc. Table 12 contains the results.

The cost of spraying per tree was as follows: Materials, 28 cents; labor, 13 cents; total, 41 cents, or \$24.90 per acre. The profits due to spraying were \$410.10 per acre. The trees from which apples were counted and graded were supposed to be a good average for the orchard. The acre estimates are made up by using these as a basis.

The spraying was an almost complete protection against scab. The rather high percentage of worms was due to an outbreak of the side worms late in the summer. There was only a bare trace of codling moth. The blossom end rot promised for a time to be a

Table 11.—Results of Spraying in Jackson Orchard up to June 30, 1914

Variety	Treatment	Percentage insect, disease and spray injury							Percentage of sound, unblemished fruit
		Worms	Cur- culio	Scab	Cedar rust	Rots	Spray injury	Cold injury (Russet- ing)	
Ben Davis	Sprayed	0.1	1.7	3.1	1.1	1.9	1.1	16.9	73.7
	Check, unsprayed	0.9	3.86	81.2	0.3	2.3	...	0	4.6

Table 12—Harvesting Data in the Jackson Orchard, Republic

Variety	Treatment	Percentage insect, disease and spray injury						Marketable fruit per tree	Value of fruit per acre
		Worms	Cur-culio	Scab	Rots	Cedar rust	Cold injury		
Ben Davis	Sprayed	13.3	6.5	1.2	4.8	1.2	17.7	12 bu. No. 1 7 bu. No. 2 $1\frac{1}{2}$ bu. culls	\$448.80
	Check, unsprayed	28.7	5.4	85.4	18.1	0.4	...	$1\frac{5}{8}$ bu. culls	\$ 13.80

very serious menace to the crop; however, the figures show that the spraying reduced the injury caused by this disease more than 13 per cent.

The P. R. Jaeger Orchard (Boonville, Cooper County). This orchard was located in the "loess" soil of the Missouri river hills. The trees were 15 to 20 years of age and in a fairly vigorous condition, despite the fact that they were badly infested with San Jose scale. Thirty-one Ben Davis trees were selected for the demonstration plat. The trees were sprayed three times as follows:

April 4, with lime sulphur 1-8.

May 8, with lime sulphur 3-100, plus 3 lbs. arsenate of lead.

June 2, with lime sulphur 3-100, plus 5 lbs. arsenate of lead.

The first application was an experiment to find if it is practicable to combine a dormant spray (used against scale) with the regulation cluster bud or first scab spray. This application was made very late for a dormant spray; some of the leaves having already been out for several days, while some of the buds were just beginning to show green. This was about a month later than the dormant spray is usually applied, but was still a little early for the first scab spray. The injury to the leaves was very slight. The cluster buds themselves apparently were entirely unhurt.

On July 2 notes were taken showing the results of the spraying up to that date. Some scale was observed on the unsprayed trees, while the sprayed trees were practically free from signs of this insect. The remaining results are tabulated in Table 13.

The figures show that scab, as well as the codling moth and curculio, was very prevalent. In addition to the 29.6 per cent of scab on the unsprayed fruit, a high percentage of the leaves on the check trees were affected with this disease. When the leaves of the apple are attacked by scab early in the season, they nearly always drop off before mid-summer, and badly infected trees will be seriously injured by loss of foliage by this cause.

September 27 Mr. Jaeger reported as follows: "The block of trees under your control is doing fine and is making a nice show. Most of the trees are heavy laden with nicely colored fruit. The apples are going to be of fine quality with the exception of much scale specks. The result of the heavy spraying speaks for itself, as many other trees in the neighborhood that were not sprayed have already lost their fruit. With several dormant sprayings perhaps the scale can be destroyed."

The fruit was harvested about the middle of October when final notes were taken. These are summarized in Table 14.

Table 13.—Results of Spraying the Jaeger Orchard up to July 2, 1914

Variety	Treatment	Percentage insect, disease and spray injury						Percentage of sound, unblemished fruit
		Worms	Curculio	Scab	Cedar Rust	Rots	Spray Injury	
Ben Davis	Sprayed	0.5	6.0	1.7	0	0	1.0	89.3
	Check, unsprayed	37.1	16.0	29.6	0	0	....	17.3

Table 14—Harvesting Data, Jaeger Orchard, Boonville

In addition to the data given in the table, it may be mentioned that there was a small percentage of scale on the fruit of the sprayed trees, but no signs of the insect could be detected on the twigs. The unsprayed trees were encrusted with scale and so numerous were these insects that the trees were clearly injured severely and apparently almost ready to die.

The summer notes that are given in Table 13 showed that the combined spray almost completely controlled the scab up until July 2. From Table 14 it is learned that there was no scab to be found on the sprayed trees at harvesting time. This was because the few apples that were affected in early summer had dropped off. From Table 14 it is further noticed that all the fruit on the unsprayed trees dropped off before harvesting time, due to attacks of the insects and diseases. It might be added that all the apple trees in this vicinity that were not sprayed cast their fruit by September or earlier.

The cost of spraying per tree was as follows: Materials, 31 cents; labor, 25 cents; total, 56 cents, or \$33.90 per acre. Since the check trees produced no fruit whatever, the net profits due to spraying in this case amounted to \$97.90 per acre.

The Dr. E. L. Johnston Orchard (Waverly, Lafayette County). This orchard consisted of Gano and Jonathan trees 18 to 25 years old. The trees were growing in fertile soil and were very large. The number of trees in the demonstration plat was 66. A gasoline power spraying outfit was used. The trees were in a very vigorous, thrifty condition and had been well pruned.

The orchard was sprayed four times as follows:

April 18, with lime sulphur 3-100, plus 5 lbs. arsenate of lead.

May 8, with lime sulphur 3-100, plus 6 lbs. arsenate of lead.

May 23, with lime sulphur 3-100, plus 5 lbs. arsenate of lead.

July 9, with Bordeaux mixture 8-8-100, plus 6 lbs. arsenate of lead.

The results up to June 15 are shown in Table 15.

The table shows 9 per cent of spray injury. While this slight russetting may have been due to spraying, it is more probable that it was caused by the cold weather in April. These notes were taken before the last spraying was given, so that the russetting cannot be attributed to the Bordeaux mixture.

As might have been expected from the rather high percentage of codling moth injury on June 15, 79.4 per cent of the fruit at harvesting time was affected by worms. Not all of this was due to the work of the codling moth, however, as the side worms were very numerous. The curculio injury on both the sprayed and unsprayed trees was

Table 15.—Results of Spraying Johnston Orchard up to June 15, 1914

Variety	Treatment	Percentage insect, disease and spray injury						Percentage of sound, unblemished fruit
		Worms	Curculio	Scab	Cedar Rust	Rots	Spray Injury (Russet- ing)	
Gano	Sprayed	0.4	4.6	0.2	0	0	9.1	85.4
	Check, unsprayed	24.5	17.6	12.2	0	0	....	48.9

Table 16—Harvesting Data, Johnston Orchard, Waverly

Variety	Treatment	Percentage insect, disease and spray injury						Marketable fruit per tree	Value of fruit per acre of 60 trees
		Worms	Curculio	Scab	Rots	Cedar rust	Russetting		
Gano	Sprayed	6.5	0.1	0	2.6	0	14.2 Frost	4 bu. No. 1 4 bu. No. 2 $1\frac{1}{2}$ bu. culls	\$188.40
	Check, unsprayed	79.4	1.9	0	21.9	0	...	$\frac{1}{4}$ bu. No. 2 $\frac{7}{8}$ bu. culls	\$ 12.60

very light. Just why the percentage is so very low, is not clear. While some of the fruit affected by curculio early in the season may fall off, provided the eggs hatch, all of the fruit so affected rarely ever drops. The blossom end rot was very bad in this orchard, although the spraying seems to have controlled this disease to within 2.6 per cent.

The cost of spraying per tree was as follows: Materials, 33.8 cents; labor, 17.7 cents; total, 51.5 cents, \$30.90 per acre. The cost of spraying in this case seems to be much higher than usual, but this was due entirely to the large size of the trees. The net profits from spraying amounted to \$144.80 per acre.

The Kelsey Orchard (Near St. Joseph, Buchanan County). This was a commercial orchard consisting of Winesap and other varieties. Two long rows of Winesap were selected for the spraying test. The trees were 10 to 12 years old and, while growing on hill land, were in good condition. The soil appeared to be fairly fertile and the orchard had been well cultivated. The trees had been fairly well pruned, although too many of the lower branches had been removed. The spraying was done with a Cushman power sprayer with a discharge capacity of ten gallons per minute. The four applications were made as follows:

April 22, with lime sulphur 4-100.

May 7, with lime sulphur 3-100, plus 4 lbs. arsenate of lead.

May 29, with lime sulphur 3-100, plus 5 lbs. arsenate of lead.

July 8, with arsenate of lead 6 lbs. to 100 gallons of water.

Notes taken July 8, after the "June drop" was over, are given in Table 17.

Codling moth was controlled absolutely, while curculio were present in considerable numbers, even where sprayed: No diseases were present even where not sprayed.

Final notes were taken in this orchard when the fruit was harvested late in October. The results are given in Table 18.

The final notes showed much better results from the spraying than did the figures taken on July 8. At harvesting time, 86 per cent of the unsprayed fruit was affected with codling moth and side worms, as against 7.8 per cent where sprayed. One-third or more of the apples were affected with both curculio and worms. The curculio were very bad on the unsprayed fruit while there were only 7.5 per cent where sprayed. The cost of spraying per tree was as follows: Materials, 21.3 cents; labor, 10.7 cents; total, 32 cents, or \$19.20 per acre. The net profits due to spraying amounted to \$184.75 per acre.

Table 17—Results of Spraying Kelsey Orchard up to July 8, 1914

Variety	Treatment	Percentage insect, disease and spray injury						Percentage of sound, unblemished fruit
		Worms	Curculio	Scab	Cedar Rust	Rots	Spray Injury	
Winesap	Sprayed	0	9.5	0	0	0	0	90.5
	Check, unsprayed	33.3	11.3	0	0	0	....	53.4

Table 18—Harvesting Data, Kelsey Orchard, St. Joseph

Variety	Treatment	Percentage insect, disease and spray injury						Marketable fruit per tree	Value of fruit per acre of 60 trees
		Worms	Curculio	Scab	Rots	Cedar rust	Spray injury		
Winesap	Sprayed	7.8	7.5	0	0	0	0	11½ bu. Nos. 1 and 2 3½ bu. culls	\$237.50
	Check, unsprayed	86.3	56.4	0	0	0	...	½ bu. No. 2 5½ bu. culls	\$ 33.60

The G. V. Kline Orchard (Pierce City, Lawrence County). The part of Mr. Kline's orchard selected for the spraying test consisted of 50 Jonathan trees, 10 years old. While the soil appeared to be fertile, the trees for some reason were not very large for their age; however, the orchard had been cultivated for several years and the trees were in a thrifty condition. For the most part, a barrel spraying outfit was used. The orchard was sprayed four times. The applications were made as follows:

April 10, with Bordeaux mixture 6-6-100.

May 1, with Bordeaux mixture 3-5-100, plus 3 lbs. arsenate of lead.

May 22, with Bordeaux mixture 4-6-100, plus 4 lbs. arsenate of lead.

June 29, with Bordeaux mixture 6-8-100, plus 5 lbs. arsenate of lead.

Table 19, below, shows the results of spraying up to June 21.



Figure 1. Class in agriculture from the Pierce City High School, attending a spraying demonstration. One student is holding the spray rod and another is operating the hand pump.

The figures in the table show that both insects and diseases were controlled by the spraying. However, there was a very high percentage of spray injury. Apparently this was one season when it was unsafe to use Bordeaux mixture for the calyx spray, even in a dilute form and with an excess of lime. From our experience this year, and in previous years, we are now prepared to advise that the calyx spray always be made with lime sulphur. Fully 15 per cent of the russetting was undoubtedly due to cold injury in April. These results are not shown in the table.

Table 19—Results of Spraying Kline Orchard up to June 21, 1914

Variety	Treatment	Percentage insect, disease and spray injury						Percentage of sound, unblemished fruit
		Worms	Curculio	Scab	Cedar Rust	Rots	Spray Injury	
Jonathan	Sprayed	0	3.0	0	0	0	80.0	2.4
	Check, unsprayed	2.3	29.3	17.6	0.6	0	....	23.5

The fruit was harvested in September, and final notes taken. The results are tabulated in Table 20.

The figures in the table show a rather high percentage of worms in the fruit from the sprayed trees—23 per cent. However, the unsprayed trees show 75.4 per cent of these insects.

The cost of spraying, per tree, was as follows: materials, 8.6 cents; labor, 8.4 cents; total, 17 cents, or \$10.20 per acre. The profits due to spraying amounted to \$93.60 per acre.

The Lebanon Orchard Company Orchard, (Lebanon, Laclede County). The orchard was 18 years old. The plat selected for the experiment consisted of 100 trees in a solid 100-acre block of Ben Davis. This same plat was used for demonstration purposes in 1913. (See page 192.)



Figure 2. Member of the University of Missouri faculty conducting a spraying demonstration in Southwestern Missouri, with a barrel sprayer.

The trees were not particularly vigorous, but were in fair condition, considering that the previous season was exceedingly dry. The orchard taken as a whole was almost free from canker disease. The orchard had not been cultivated in several years. Some of the trees in the sprayed plat had been pruned, while others had not. The figures that are given in the table of results are an average of all the trees.

The trees were sprayed four times as follows:
April 9, with lime sulphur 3-100.

Table 20—Harvesting Data, Kline Orchard, Peirce City

Variety	Treatment	Percentage insect, disease and spray injury						Marketable fruit per tree	Value of fruit per acre of 60 trees
		Worms	Curculio	Scab	Rots	Cedar rust	Russetting		
Jonathan	Sprayed	23.0	4.3	0	0.29	0.4	100.0	1½ bu. No. 1 1¾ bu. No. 2 2¼ bu. culls	\$124.80
	Check, unsprayed	75.4	30.0	0	2.3	0	...	1/10 bu. No. 2 1¼ bu. culls	\$ 21.00

May 6, with lime sulphur 3-100, plus 6 lbs. arsenate of lead.
May 26, with lime sulphur 3-100, plus 4 lbs. arsenate of lead.
July 3, with Bordeaux mixture 8-8-100, plus 5 lbs. arsenate of lead.

The results of the spraying, up to July 3, are given in Table 21.

There were very few insects, even on the unsprayed trees. There was, however, a very serious epidemic of apple scab. This disease the spraying almost entirely controlled. The unsprayed trees showed 84.7 per cent of scab.

The fruit was harvested October 17. The results of counting and grading are given in Table 22.

The figures in this table show that the curculio came in rather late; also there was a considerable outbreak of side worms. The blossom end rot for a time promised to become very serious. The spraying apparently did not have very much effect in controlling this disease. Apple scab continued to spread, to some extent, late in the season. By comparing figures here with those in Table 21 it will be seen that many of the apples attacked by scab early in the season evidently fell off. At harvesting time the sprayed trees showed 18.5 per cent of scab, while the unsprayed trees showed 40.2 per cent.

The cost of spraying was as follows, per tree: materials, 21.4 cents; labor, 11.5 cents; total, 33 cents, or \$19.80 per acre. The net profits due to spraying amounted to \$81.00 per acre.

The J. S. Livesay Orchard (Five Miles N. E. of Independence, Jackson County). The demonstration plat consisted of 44 trees in one corner of a small commercial orchard. The trees were 10 years old and had been cultivated and were in a thrifty condition. All of the trees had been well pruned. The sprayer used was a Bean hand-power outfit. This was the same outfit that was used in spraying the Davis orchard. The following three applications were given:

April 20, with lime sulphur 3-100.

May 5, with lime sulphur 3-100, plus 6 lbs. arsenate of lead.

May 27, with lime sulphur 2-100, plus 4 lbs. arsenate of lead.

The first notes were taken on June 16, after the "June drop" was over. Results are given in Table 23.

There was only a trace of either insects or diseases on the sprayed trees, while the unsprayed trees showed 24.8 per cent, 65.6 per cent, and 4.8 per cent of worms, curculio and scab, respectively.

The crop was harvested and final notes taken about October 20. Results are given in Table 24.

Curculio injury on the sprayed fruit was unusually high—23.1 per cent. Just why this was is not clear. There was no fruit worth

Table 21—Results of Spraying Lebanon Orchard Co. Orchard up to July 3, 1914

Variety	Treatment	Percentage insect, disease and spray injury						Percentage of sound, unblemished fruit
		Worms	Curculio	Scab	Cedar Rust	Rots	Spray Injury	
Ben Davis	Sprayed	0	0.1	4.44	0.3	0	0	79.4
	Check, unsprayed	0.8	1.7	84.7	0	0	...	3.4

Table 22—Harvesting Data in the Lebanon Orchard Co. Orchard, Lebanon

Variety	Treatment	Percentage insect, disease and spray injury						Marketable fruit per tree	Value of fruit per acre of 60 trees
		Worms	Cur- culio	Scab	Rots	Cedar rust	Spray injury		
Ben Davis	Sprayed	17.4	11.7	18.5	11.3	1.5	0.2	2½ bu. No. 1 1 bu. No. 2 ½ bu. culs	\$146.40
	Check, unsprayed	14.1	25.5	40.2	13.6	6.0	...	7/8 bu. No. 2 1¾ bu. culs	\$ 45.60

Table 23—Results of Spraying the Livesay Orchard up to June 16, 1914

Variety	Treatment	Percentage insect, disease and spray injury						Percentage of sound, unblemished fruit
		Worms	Curculio	Scab	Cedar Rust	Rots	Spray Injury	
Ben Davis	Sprayed	1.2	7.0	0.6	0	0	0	91.2
	Check, unsprayed	24.8	65.6	4.8	0	0	...	9.6

Table 24—Harvesting Data in Livesay Orchard, Independence

gathering on the unsprayed trees; all having been destroyed by the attacks of insects and diseases.

In a personal letter, under date of September 10, Mr. Livesay made the following comments: "We are highly pleased with the results of the spraying. We thank you for the interest you have shown and the help you have given us. The apples from my orchard took five first prizes and five second prizes at the Independence fair. Apple men say they have seen very few orchards that would compare with mine."

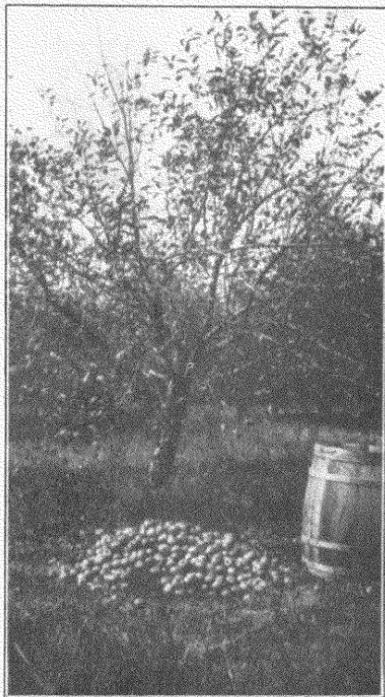


Figure 3. At left, sprayed tree bore 4 barrels of apples 87.3 per cent marketable; at right, unsprayed tree bore 1 barrel of fruit 12.7 per cent marketable. Note scanty foliage on unsprayed tree. Unsprayed trees commonly lose most of their leaves in August. This often leaves them too weak to produce fruit buds for next year's crop.

The cost of spraying was as follows, per tree: materials, 10.3 cents; labor, 13.9 cents; total, 24 cents, or \$14.52 per acre. This represents a net profit, due to spraying, of \$115.80 per acre. This was the first time the orchard had ever been sprayed. Mr. Livesay sold the crop on the trees for cash.

The G. K. Murray Orchard (Willard, Green County). The orchard was located in clay loam soil; was cultivated a few years ago but now growing in sod. The trees were pruned the spring of 1914 for the first time in several years. Trees were healthy and making good growth. Some San Jose scale present. Varieties consisted of Ben Davis, Grimes, York and others. The trees were fifteen years old. The demonstration plat consisted of fifty trees. A gasoline power sprayer was used, and the following applications given:

April 1, with lime sulphur 3-100.

May 4, with lime sulphur 3-100, plus 6 lbs. arsenate of lead.

May 25, with lime sulphur 2-100, plus 5 lbs. arsenate of lead.

July 2, with lime sulphur 3-100, plus 4 lbs. arsenate of lead.

The first set of notes showing results of spraying was taken July

2. The figures are given in Table 25.

It should be explained that the first application was made rather early as a part of the orchard was given the dormant spray on the same day and a second trip could not be made. Even though applied from two to three weeks early, the scab spray was very effective, there being only 1.1 per cent of the disease on the sprayed trees, while there was 56.7 per cent on the unsprayed.

For purposes of comparison, notes were taken on a neighboring orchard July 2. This orchard had not been sprayed. The variety was Ben Davis. This showed 1.9 per cent of worms; 12.3 per cent of curculio, and 64 per cent of scab. It is to be regretted that no harvesting data from this orchard are available, although it is very probable that only a small percentage, if any, of the fruit was of commercial grade.

The apples in the Murray orchard were harvested in October and the results are tabulated below in Table 26.

It should have been explained before, that inexperienced men did the spraying in this orchard for the most part. This probably accounts for the high percentage of scab on the sprayed trees. The cost of spraying four times, per tree, was as follows: materials, 28.2 cents; labor, 10.8 cents; total, 39 cents, or \$23.40 per acre. The profits due to spraying amounted to \$181.80 per acre.

The F. F. Osterloch Orchard (Hartsburg, Boone County). This orchard was located in rich bottom land near the Missouri river. The trees were 15 to 20 years old, and of good size and vigor. They were growing in sod. Varieties consisted of Ralls (Geniton), Willow, Jonathan and Ben Davis. The demonstration plat consisted of fifty-four trees, and included the four varieties mentioned above. The trees were sprayed three times, the first two applications being

Table 25—Results of Spraying Murray Orchard up to July 2, 1914

Variety	Treatment	Percentage insect, disease and spray injury							Percentage of sound, unblemished fruit
		Worms	Cur- culio	Scab	Cedar rust	Rots	Spray injury	Scale	
Ben Davis	Sprayed	0	2.3	1.1	0	0	2.4	0	81.8
	Unsprayed	0.1	8.1	56.7	0.1	0	0	2.3	11.7

Cluster spray omitted—dormant spray applied late, April 1.

Ben Davis	Sprayed	0	0.7	4.6	0	0.7	1.4	0	83.5
-----------	---------	---	-----	-----	---	-----	-----	---	------

Table 26—Harvesting Data, Murray Orchard, Willard

Variety	Treatment	Percentage insect, disease and spray injury						Marketable fruit per tree	Value of fruit per acre of 60 trees
		Worms	Curculio	Rots	Scab	Cedar rust	Spray injury		
Ben Davis	Sprayed	7.4	4.0	2.0	33.0	0	3.8	7.2 bu. No. 1 3.1 bu. No. 2 $1\frac{1}{2}$ bu. culls	\$237.00
	Unsprayed	15.7	10.5	2.3	87.4	0	...	$\frac{1}{2}$ bu. No. 2 $2\frac{1}{2}$ bu. culls	31.80

made by the owner. The work was done with a gasoline power sprayer, the applications being made as follows:

April 20, with lime sulphur 3-100 plus 4 lbs. arsenate of lead.

May 11, with lime sulphur 3-100 plus 4 lbs. arsenate of lead.

June 3, with lime sulphur 3-100 plus 5 lbs. arsenate of lead.

The first notes were taken July 11; the results are given in Table 27.

Apparently there was no scab in this vicinity. Codling moth were abundant but the spraying afforded good protection. The side worms became very bad late in the summer. The codling moth on the unsprayed trees increased enormously in number, and they soon spread over all of the fruit on those trees. At harvesting time, late in October, no fruit of marketable grade was left on the check trees, all of it having rotted or dropped off as the result of insect and disease injury. The sooty mold, a disease which is more likely to appear in low, damp places than elsewhere, was exceedingly bad. This disease is probably worse on Ralls (Geniton) than on any other variety. The third spray ought to control this disease, and under normal conditions will do so. This time, however, the sprayed fruit showed 39.2 per cent of sooty mold.



Figure 4. One of the demonstration orchards. Owned by C. D. Peck, Pierce City. This orchard was sprayed in 1913 with a barrel pump (See Figure 1), when the profits due to spraying amounted to \$161.12 per acre. Sprayed with a gasoline power outfit in 1914, the profits were \$300.00 per acre.

The cost of spraying three times, per tree, was as follows: materials, 16.5 cents; labor, 9 cents; total, 25.5 cents, or \$15.30 per acre. Profits due to spraying amounted to \$47.70 per acre.

Table 27—Results of Spraying Osterloch Orchard up to July 11, 1914

Variety	Treatment	Percentage insect, disease and spray injury						Percentage of sound, unblemished fruit
		Worms	Curculio	Scab	Cedar Rust	Rots	Spray Injury	
Ralls (Geniton)	Sprayed	3.1	11.7	0.4	0	0	0	85
	Unsprayed	42.0	14.5	0	0	0	...	46

The C. D. Peck Orchard (Pierce City, Lawrence County). This was a small commercial orchard consisting of four acres, located on slightly rolling land. The soil was gravelly and fairly fertile. The orchard was growing in sod, although it had been cultivated and manured a year or two previously. The trees were pruned during the winter of 1913. Varieties consisted of Ben Davis, Gano, York, Arkansas (Black Twig) and Missouri (Missouri Pippin). Sixty-eight trees made up the demonstration plat.

The spraying was done with a gasoline power outfit. The materials used and the dates of application were as follows:

April 10, with lime sulphur 3-100, plus 2 lbs. powdered arsenate of lead.

May 1, with lime sulphur 3-100, plus 3 lbs. powdered arsenate of lead.

May 22, with lime sulphur 3-100, plus 5 lbs. arsenate of lead paste.

June 29, with lime sulphur 3-100, plus 5 lbs. arsenate of lead paste.

Complete notes were taken in June after all of the imperfectly pollinated fruit had dropped, and the results are given in Table 28.

No notes were taken on the Ben Davis trees.

Curculio and apple scab were the pests that were most abundant. However, the spraying controlled these almost completely.

During the summer, in a personal letter, Mr. Peck made the following comments: "After trying out some plats of Bordeaux and soluble sulphur I am now a firm believer in the value of commercial lime sulphur. I sure have gotten a wonderful lot of good from my experience with you and will always be ready to let the University demonstrate here. The check trees in your plats are a wonder to every one. The Missouri Pippin and Gano have only a few apples left and they are faulty. The worms and scab got them all. There has been a great number of people come to see the results of our spraying work."

The fruit was harvested late in October. The results are summarized in Table 29.

Side worms became very abundant late in the summer. Practically the full percentage of injury from worms mentioned in the table was caused by this insect. Scab also was very bad, and for some reason the spraying did not afford complete protection. However, even under these conditions the spraying was immensely profitable.

The cost of spraying four times per tree, was as follows: materials 15.1 cents; labor, 9.3 cents; total, 24.4 cents, or \$14.60 per acre. The

Table 28—Results of Spraying Peck Orchard up to June 21, 1914

Variety	Treatment	Percentage insect, disease and spray injury						Percentage of sound, unblemished fruit
		Worms	Curculio	Scab	Cedar Rust	Rots	Spray Injury	
Gano	Sprayed	0	0	0	0	0	11.5	85.3
	Unsprayed	1.7	18.4	25	0.3	0	...	28.2
York	Sprayed	0	1.5	0	0	0	0	94.6
	Unsprayed	5.4	8.4	7.4	0	0	...	77.1
Arkansas (Black Twig)	Sprayed	0	0.9	0	0	0	0	93.5
	Unsprayed	3.0	20.4	21.0	0	0	...	38.8
Missouri (Pippin)	Sprayed	0	0	0	0	0	0.4	95.2
	Unsprayed	2.2	38.2	12.4	0	0	...	42.2

Table 29—Harvesting Data, Peck Orchard, Peirce City

Variety	Treatment	Percentage insect, disease and spray injury					Marketable fruit per tree	Value of fruit per acre of 60 trees
		Worms	Curculio	Rots	Seab	Spray injury		
Arkansas (Black Twig)	Sprayed	21.3	13.1	5.8	2.0	1.0	1 bu. No. 1 $\frac{2}{5}$ bu. No. 2 $\frac{1}{5}$ bu. culls	\$ 85.80
	Unsprayed	43.7	6.2	18.5	68.7	...	$\frac{1}{8}$ bu. culls	1.30
York	Sprayed	14.0	19.4	1.5	19.0	0	6 bu. No. 1 $7\frac{1}{2}$ bu. No. 2 $1\frac{1}{2}$ bu. culls	823.80
	Unsprayed	59.0	10.4	18.1	27.6	...	.1 bu. No. 2 .9 bu. culls	1.65

Table 29—Continued

Variety	Treatment	Percentage insect, disease and spray injury					Marketable fruit per tree	Value of fruit per acre of 60 trees
		Worms	Curculio	Rots	Scab	Spray injury		
Missouri (Pippin)	Sprayed	8.2	9.2	8.8	15.1	1.0	2 bu. No. 1 1 bu. No. 2 $\frac{1}{2}$ bu. culls	\$229.80
	Unsprayed	79.0	42.1	26.3	32.0	...	.1 bu. culls	0.90
Gano	Sprayed	13.3	11.3	1.6	17.7	35.1	$1\frac{1}{2}$ bu. No. 1 $2\frac{2}{3}$ bu. No. 2 $\frac{2}{3}$ bu. culls	110.20
	Unsprayed	90.2	24.6	24.1	63.6	...	$1\frac{1}{2}$ bu. culls	12.00

average net profits due to spraying for all varieties, were \$300.48 per acre.

The W. C. Rice Orchard (Smithville, Clay County). This was one of the advisory orchards. The owner decided to spray and purchased a gasoline power sprayer for the purpose. Being entirely ignorant as to what chemicals to use, and how to apply them, he appealed to the University for assistance. Unfortunately as many demonstration orchards as could be handled with the limited force had already been arranged for. Nothing could be done except to advise the owner what to do. A visit was paid to the orchard and plans made for the spraying. However, it was already too late to make the cluster spray, the important application for controlling apple scab.

On September 18 the owner made the following report: "I have a very short apple crop. Had only forty bushels of first class Jonathan. Sold them to neighbors for \$1.35 per bushel, and have contracted most of my Ben Davis and Willow at \$1.00 per bushel, and culls at 30 cents per bushel. Think I will have about 300 bushels of Ben Davis, Willow and Gano. I gave my orchard only one spray, which was the calyx. Got good results as there are very few worms. The hot dry weather caused them to drop badly. Believe the spraying caused them to stay on as well as they did as other orchards which were not sprayed dropped all their fruit."

The J. E. Roberts Orchard (Maysville, DeKalb County). This was a small home orchard of very old trees growing in sod, and had received no pruning. The trees were 28 years old, and consequently contained much dead wood and considerable canker. The spraying was done with a barrel outfit. Applications were made as follows:

April 24, with lime sulphur 3-100.

May 8, with lime sulphur 3-100, plus 4 lbs. arsenate of lead.

May 30, with lime sulphur 3-100, plus 5 lbs. arsenate of lead.

The trees were too large to spray properly with a barrel outfit. This was specially noticeable when the calyx spray was made, as at that time the wind was very high. The one line of hose was too short to get around the trees properly. Notes taken on June 18 showed the results given in Table 30.

No diseases were present except apple blotch. The spraying gave almost complete protection from codling moth, and almost so for curculio.

While no exact data are available showing results at harvesting time, the owner reports as follows: "Rambo and Roman Stem all blew off during a wind storm. Wealthy, sprayed, 75 per cent

Table 30—Results of Spraying J. E. Roberts' Orchard up to June 18, 1914

Variety	Treatment	Percentage insect, disease and spray injury							
		Worms	Curculio	Scab	Cedar rust	Rots	Spray injury	Blotch	Sound fruit
Mixed	Sprayed	1.1	5.0	0	0	0	0	0	91.1
	Unsprayed	35.1	28.5	0	0	0	...	2.8	33.3

sound; unsprayed, all rotted. Maiden Blush, sprayed, 75 per cent sound and very fine; unsprayed, all rotted."

The cost of spraying three times amounted to 35 cents per tree, or \$21.00 per acre. Since no figures showing the yield are available, it is impossible to estimate the profits due to spraying.

The W. M. Roberts Orchard (Near Weatherby, DeKalb County). This was a small home orchard consisting of young trees of various varieties. The spraying was done with a barrel outfit, applications being made as follows:

April 24, with lime sulphur 3-100.

May 8, with lime sulphur 3-100, plus 4 lbs. arsenate of lead.

May 30, with lime sulphur 3-100, plus 5 lbs. arsenate of lead.

Thirty-two twelve-year-old trees were sprayed. No summer notes are available. Complete notes were not taken at harvesting time; however, the owner reports as follows: "Two Ben Davis trees contained a total of 625 apples. Of these 72.7 per cent were good clean fruit; 12 per cent were affected with worms; 2 per cent with rots; and 13.3 per cent with cedar rust. From one Minkler tree, 600 apples were counted. Three per cent of these contained worms; 5 per cent, rot; 2 per cent, cedar rust; and 90 per cent were clean. From one Paradise Sweet tree, 100 apples were gathered. These showed 2 per cent worms; 2 per cent rots; 44 per cent cedar rust; and 52 per cent clean."

The cost of spraying three times, per tree, was as follows: materials, 5 cents; labor, 7.6 cents; total 12.6 cents, or \$7.56 per acre. Yield notes not being available, no estimate can be made of the profits due to spraying.

The A. E. Rose Orchard (Republic, Greene County). This was a small commercial orchard 23 years old, growing in good soil. The trees were moderately vigorous. Trees had received considerable pruning; they were headed very high. The spraying was done with a hand power outfit. Applications were made as follows:

April 13, with lime sulphur 3-100, plus 5 lbs. arsenate of lead paste.

May 4, with lime sulphur 3-100, plus 3 lbs. powdered arsenate of lead.

May 23, with lime sulphur 3-100, plus 5 lbs. arsenate of lead paste.

Notes were taken on June 30, and results are tabulated in Table 31.

Unfortunately no data are available showing conditions on unsprayed Winesap and Limber Twig, nor on the sprayed Ben Davis. However, if we may judge from the Maiden Blush for comparison

Table 31—Results of Spraying the A. E. Rose Orchard up to June 30, 1914

Variety	Treatment	Percentage insect, disease and spray injury						Percentage of sound, unblemished fruit
		Worms	Curculio	Scab	Cedar Rust	Rots	Spray Injury	
Winesap	Sprayed	1.6	7.6	16.9	0.3	0	0	68.3
Maiden Blush	Sprayed	0	6.0	6.5	0	0	0	87.3
	Unsprayed	2.2	24.4	30.9	0	0	...	38.5
Limber Twig	Sprayed	0	13.4	2.6	0	0.4	0	81.9
Ben Davis	Unsprayed	1.3	13.8	45.5	0	0.6	...	34.4

between sprayed and unsprayed trees, it would seem that the spraying gave good results in controlling codling moth, curculio and scab.

The fruit was harvested in October. No data are available showing results at harvesting time, except for Ben Davis. These are given in Table 32.

The side worms were very bad in late summer. This accounts for the abnormally large percentage of injury on the sprayed fruit under the heading of worms. Why the percentage of curculio injury on the sprayed trees was greater than the unsprayed, is not clear. Either there was an outbreak of these insects at a time when the spray did not afford protection which is possible, or the spraying was not thoroughly done. The spraying seems to have been fairly beneficial in controlling the blossom end rot. On the whole, results of the spraying here were very unsatisfactory.



Figure 5. Fruit from an average tree of sprayed Jonathan from the Turner Station orchard, McBaine. Five bushels of fancy and extra fancy fruit; twenty apples more or less blemished by curculio and two apples affected with side worms.

The cost of spraying three times, per tree, was as follows: materials, 14.5 cents; labor, 18.6 cents; total, 33 cents, or \$19.80 per acre. The estimated profits due to spraying were \$77.40 per acre.

The Turner Station Orchard (Near McBaine, Boone County). This was a commercial orchard of twenty-three acres, consisting of Jonathan, Gano, and York, with a few scattering trees of Winesap. The soil was "loess" fading into clay. No cultivation had been given for five or six years. During this period the land was in clover although blue grass is gradually forming a turf around many of the trees, and is even coming in between the rows. The clover and grass

Table 32—Harvesting Data, Rose Orchard, Republic

Variety	Treatment	Percentage insect, disease and spray injury						Marketable fruit per tree	Value of fruit per acre of 60 trees
		Worms	Curculio	Rots	Scab	Cedar rust	Spray injury		
Ben Davis	Sprayed	51.7	17.1	18.9	9.4	0	16.5	3 bu. No. 1 2 bu. No. 2 1 bu. culls	\$122.40
	Unsprayed	55.9	5.0	41.3	11.4	0	...	$\frac{1}{2}$ bu. No. 2 $1\frac{3}{4}$ bu. culls	25.20

is mowed twice during the summer and allowed to remain on the ground as a mulch. For the most part the trees were in a thrifty condition. More than one-half of the trees were thoroughly pruned during the month of June, 1913; the remainder were pruned in June, 1914.

In this orchard extensive tests were made with several kinds of spraying materials used in different combinations. The experimental plats included a total of more than 700 trees. The spraying was done with a gasoline power spraying outfit. There were twelve plats of approximately one acre each. The orchard was sprayed twice as follows:

The cluster or scab spray, April 23-27 inclusive, with:

- (1) Lime sulphur (specific gravity 1.009) or about 3-100;
- (2) Bordeaux mixture 6-6-100;
- (3) Soluble sulphur 2 lbs. to 100 gallons of water;
- (4) Prepared Bordeaux mixture 20 lbs. to 100 gallons of water;
- (5) Arsenate of lead paste 4 lbs. to 100 gallons of water;
- (6) Pyrox 1 lb. to 9 gallons of water.

The calyx spray, or second application was made May 2-6 inclusive, with:

- (1) Lime sulphur 3-100, plus 6 lbs. arsenate of lead paste;
- (2) Bordeaux mixture 3-5-100, plus 6 lbs. arsenate of lead paste;
- (3) Soluble sulphur 2-100, plus 6 lbs. arsenate of lead paste;
- (4) Lime sulphur 3-100, plus 2 lbs. powdered arsenite of zinc;
- (5) Bordeaux 3-5-100, plus 3 lbs. powdered arsenate of lead;
- (6) Bordeaux 3-5-100, plus 6 lbs. tri-plumbic arsenate of lead;
- (7) Prepared Bordeaux 16 lbs. to 100 gallons of water;
- (8) Bordeaux 3-5-100, plus 4 lbs. arsenite of zinc paste;
- (9) Arsenate of lead paste 6 lbs. to 100 gallons of water;
- (10) Pyrox 1 lb. to 9 gallons of water.

While a block of trees was left unsprayed to check the results, it so happened that most of them did not have a good bloom so it was decided to use as a check a 20-acre orchard, of the same varieties, on an adjoining farm. This orchard was growing in the same kind of soil; consisted of Jonathan and Gano, 10 years old, and had never been sprayed. All of the trees had been pruned and the entire orchard was cultivated.

The first set of notes showing the results of the spraying was taken on June 13, and the second set on June 27. These two sets of notes were averaged and the results are given in Table 33.

The figures show very plainly that while scab was not very abundant in the unsprayed orchard, that this disease was absolutely controlled in the sprayed orchard. The figures further show that,

Table 33—Results of Spraying Turner Station Orchard up to June 27, 1914

Plat No. and spray material used	Variety	Percentage insect, disease and spray injury					Percentage of sound, unblemished fruit
		Worms	Curculio	Scab	Cedar rust	Spray injury (Russeting)	
Check (Unsprayed)	Jonathan	4.1	33.2	0.6	12.1	...	51.6
	Gano	6.5	25.7	16.4	0	...	56.5
Plat I 1st application: Lime sulphur 3-100 2nd application: Lime sulphur 3-100 Arsenate of lead 6 lbs.	Jonathan	0.2	1.7	0	2.7	0.2	94.7
	Gano	0	2.5	0	0.8	0.4	96.4
	Winesap	0.6	1.5	0.2	0	0	98.1
Plat II 1st application: Bordeaux 6-6-100 2nd application: Bordeaux 3-5-100 Arsenate of lead 6 lbs.	Jonathan	0.25	3.05	0	5.2	47.5	43.9
	Gano	0	11.6	0	1.8	27.7	28.6

Table 33—Continued

Plat No. and spray material used	Variety	Percentage insect, disease and spray injury					Percentage of sound, unblemished fruit
		Worms	Curculio	Scab	Cedar rust	Spray injury (Russetting)	
Plat III 1st application: Sol. sulphur 2-100	Gano	0	2.7	0.1	1.0	1.25	95.5
2nd application: Sol. sulphur 2-100 Arsenate of lead 6 lbs.							
Plat IV 1st application: Lime sulphur 3-100	Jonathan	0	4.1	0	3.8	0	92.5
2nd application: Lime sulphur 3-100 Powdered arsenate of lead 3 lbs.							
	Winesap	0	2.4	0	1.5	0.25	97.3

Table 33—Continued

Plat No. and spray material used	Variety	Percentage insect, disease and spray injury					Percentage of sound, unblemished fruit
		Worms	Curculio	Scab	Cedar rust	Spray injury (Russetting)	
Plat V 1st application: Lime sulphur 3-100 2nd application: Lime sulphur 3-100 Arsenate of zinc powder 2 lbs.	Jonathan	0.2	3.2	0	3.0	0	92.7
Plat VI 1st application: Bordeaux 6-6-100 2nd application: Bordeaux 3-5-100 Powdered arsenate of lead 3 lbs.	Jonathan	0	1.5	0	3.9	54.6	41.6

Table 33—Continued

Plat No. and spray material used	Variety	Percentage insect, disease and spray injury					Percentage of sound, unblemished fruit
		Worms	Curculio	Scab	Cedar rust	Spray injury (Russetting)	
Plat VII 1st application: Bordeaux 6-6-100 2nd application: Bordeaux 3-5-100 Tri-plumbic arsenate of lead 6 lbs.	Jonathan	0	9.0	0	2.9	44.5	36.4
Plat VIII 1st application: Prepared Bordeaux (Bordeaux arsenate) 20-100 2nd application: Prepared Bordeaux 16-100	Jonathan	0	10.8	0	2.9	58.2	28.4

Table 33—Continued

Plat No. and spray material used	Variety	Percentage insect, disease and spray injury					Percentage of sound, unblemished fruit
		Worms	Curculio	Scab	Cedar rust	Spray injury (Russetting)	
Plat IX 1st application: Bordeaux 6-6-100 2nd application: Bordeaux 3-5-100 Arsenite of zinc paste 4 lbs.	Jonathan	0.15	2.2	0	5.5	70.8	21.7
Plat X 1st application: Bordeaux 6-6-100 2nd application: Bordeaux 3-5-100 Arsenate of lead 6 lbs.	Jonathan	0	4.9	0	3.0	52.5	49.2

Table 33—Continued

Plat No. and spray material used	Variety	Percentage insect, disease and spray injury					Percentage of sound, unblemished fruit
		Worms	Curculio	Scab	Cedar rust	Spray injury (Russetting)	
Plat XI 1st application: Arsenate of lead paste alone, 4 lbs. to 100 gals. of water. 2nd application: Arsenate of lead paste, 6 lbs. to 100 gals. of water.	Jonathan	0	4.7	0	5.7	35.4	54.9
Plat XII 1st application: Pyrox 1 lb. to 9 gals. of water. 2nd application: Pyrox 1 lb. to 9 gals of water.	Gano	0	9.2	0	0.8	60.0	30.0

for the most part, the spraying was effective in controlling curculio, and exceedingly so in controlling codling moth. There were no prominent differences as regards the efficacy of arsenate of lead powder over the paste form, or vice versa. Arsenite of zinc proved to be a very good insecticide, and there seemed to be no harmful results from its use.

The Jonathan apples were harvested about the twentieth of September, and the winter varieties about the middle of October. Special trees were selected in different plats, and also in the unsprayed orchard, and the fruit carefully harvested and graded. The essential results are shown in Table 34.

The figures in the last table show that all of the different spraying materials were efficient in controlling both diseases and insects. Scab was controlled absolutely, while injury from cedar rust was greatly reduced in all cases. The unsprayed Jonathan trees showed 14.6 per cent of this disease on the fruit, while the highest percentage of injury on any of the sprayed Jonathan was 7.3 per cent, where lime sulphur was used. However, in plat IV, where lime sulphur was also used, the cedar rust injury was only 2.5 per cent. As a rule spraying will not control this disease, or at least does so very irregularly. The reason for this is that the spores of the disease have no regular time for spreading. If trees happen to be sprayed just when the spores are being disseminated, the spraying would afford a considerable protection. It is interesting to note that the smallest amount of cedar rust injury—.4 per cent—was in plat III where the trees were sprayed with soluble sulphur. This disease does not attack the Gano very much. The highest percentage of cedar rust injury on any Gano was only 3.9 per cent. The disease was very bad on the leaves of the Jonathan.

A comparison of the different insecticides shows that arsenate of lead in the form of a powder is just as effective as the paste in controlling both codling moth and curculio. Also arsenite of zinc, both in the form of a paste and powder, was an equally good insecticide, and neither did it cause any injury to fruit or foliage. The tri-plumbic arsenate of lead, for some reason, failed to control the curculio. Bordeaux arsenate (a prepared Bordeaux mixture) controlled the codling moth, but there was rather more curculio than on the other plats; and there was no more russet on the fruit than on other plats where Bordeaux mixture was used for the calyx spray. For some reason pyrox failed to control the curculio, and the percentage of codling moth in this plat was also larger than in any of the others. This plat happened to be located next to a body of timber, which probably accounts for the high percentage of insect injury.

Table 34—Harvesting Data, Turner Station Orchard, McBaine

Plat No. and spray material used	Variety	Percentage insect, disease and spray injury					Marketable fruit per tree	Value of fruit per acre of 60 trees
		Worms	Curculio	Scab	Cedar rust	Spray injury		
Check (Unsprayed)	Jonathan	37.0	33.7	0	14.6	..	$\frac{3}{8}$ bu. No. 1 $1\frac{3}{4}$ bu. No. 2 1 bu. culls	\$ 57.12
	Gano	34.5	9.7	9.7	2.8	...	1 bu. No. 1 $\frac{3}{4}$ bu. No. 2 $1\frac{1}{4}$ bu. culls	58.50
Plat I	Gano	1.7	5.6	0	2.8	6.8	7 bu. No. 1 $1\frac{1}{2}$ bu. No. 2 $1\frac{1}{2}$ bu. culls	288.60
	Jonathan	0.8	4.0	0	7.3	0	2 bu. No. 1 1 bu. No. 2 $\frac{1}{2}$ bu. culls	170.10
Plat II Bordeaux and arsenate lead paste	Gano	2.2	4.4	0	3.9	90.6	$2\frac{3}{4}$ bu. No. 1 $2\frac{1}{4}$ bu. No. 2 $\frac{1}{2}$ bu. culls	148.44
	Jonathan	0	2.3	0	6.4	82.1	$\frac{3}{4}$ bu. No. 1 1 bu. No. 2 $\frac{1}{2}$ bu. culls	97.02

Table 34—Continued

Plat No. and spray material used	Variety	Percentage insect, disease and spray injury					Marketable fruit per tree	Value of fruit per acre of 60 trees
		Worms	Curculio	Scab	Cedar rust	Spray injury		
Plat III Soluble sulphur and arsenate of lead paste	Gano	0.2	3.1	0.2	0.4	5.1	2½ bu. No. 1 2 bu. No. 2 1½ bu. culls	\$140.16
Plat IV Lime sulphur and arsenate of lead powder	Jonathan	0.2	3.3	0	2.5	0.2	2 bu. No. 1 1½ bu. No. 2 1½ bu. culls	203.52
Plat V Lime sulphur and arsenite of zinc powder	Jonathan	0.2	3.5	0	2.4	10.5	½ bu. No. 1 1 bu. No. 2 ½ bu. culls	82.38
Plat VI Bordeaux and arsenate of lead powder	Jonathan	0.2	2.7	0	4.6	86.5	1½ bu. No. 1 1½ bu. No. 2 ¾ bu. culls	149.70
Plat VII Bordeaux and triplumbic arsenate of lead	Jonathan	1.6	14.4	0	3.0	94.6	½ bu. No. 1 2 bu. No. 2 ½ bu. culls	130.98

Table 34—Continued

Plat No. and spray material used	Variety	Percentage insect, disease and spray injury					Marketable fruit per tree	Value of fruit per acre of 60 trees
		Worms	Curculio	Scab	Cedar rust	Spray injury		
Plat VIII Prepared Bordeaux (Bordeaux arsenate)	Jonathan	1.5	7.4	0	8.0	87.8	1 bu. No. 1 $1\frac{1}{2}$ bu. No. 2 $\frac{1}{2}$ bu. culls	\$135.96
Plat IX Bordeaux and arsenite of zinc paste	Jonathan	1.9	3.0	0	7.2	86.0	$\frac{5}{8}$ bu. No. 1 1 bu. No. 2 $\frac{1}{2}$ bu. culls	90.30
Plat X Bordeaux and arsenate of lead paste	Jonathan	0.9	2.8	0	2.8	87.6	$\frac{3}{8}$ bu. No. 1 $\frac{1}{2}$ bu. No. 2 $\frac{1}{4}$ bu. culls	70.26
Plat XI Arsenate of lead paste	Jonathan	1.6	12.0	0	7.2	93.1	$1\frac{1}{8}$ bu. No. 1 1 bu. No. 2 $1\frac{1}{4}$ bu. culls	125.94
Plat XII Pyrox	Gano	4.5	36.7	1.5	2.7	40.0	$\frac{1}{2}$ bu. No. 1 $\frac{3}{8}$ bu. No. 2 $\frac{1}{8}$ bu. culls	26.82

In every case where Bordeaux was used for the calyx spray, there was a very high percentage of russetting of the fruit. This was particularly true of the Gano. The Jonathan were also badly russeted, but this variety seemed to obscure the blemish with a high color. The Gano also took on a very deep color, for the most part, but many of the trees although pruned, had very dense foliage and, therefore, shaded considerable of the fruit which failed to color enough to obscure the spray injury. Very few of the Jonathan had to go into the second grade on account of spray injury, while fully 10 per cent of the Gano were reduced from the first to the second grade on account of the russetting. The experience of the past few years shows that it is very dangerous to make the calyx spray on Gano or Ben Davis with Bordeaux mixture of any strength. The first spray may be safely made with this material, and generally the third spraying is safe, and certainly the fourth would be, but the second application should be made with lime sulphur.

The soluble sulphur plat contained perhaps the most handsome fruit in the orchard. However, the second application of this material caused a great deal of arsenic injury, particularly to the leaves. On July 12 some arsenic injury to the fruit was noticed, the calyx end of the apples being slightly blackened. At this time the trees had shed from 60-80 per cent of their leaves. Arsenic injury is first noticeable on the leaves in the form of bright red circular spots from $\frac{1}{16}$ to $\frac{1}{4}$ of an inch in diameter. These gradually become lighter in color as the dead area gets older. If there are many spots on the leaf it is certain to fall off within a few days. Fortunately the trees were young and vigorous and the loss of foliage did not appear to injure them. Had the trees been sprayed a third time with the soluble sulphur, a high percentage of the fruit would have been injured. This injury to the fruit is always at the blossom end, as the arsenic, which is set free from the insecticide, kills the calyx. This part of the apple then blackens and decays. As soluble sulphur is now made it is a dangerous material to use as a summer spray under Missouri conditions; however, it is to be hoped that the manufacturers will be able to overcome the arsenic injury as the material has great promise as a summer spray.

The trees sprayed with lime sulphur had uniformly fine, well-colored, smooth fruit with a fine finish. The finish, or luster, was not as good as those sprayed with soluble sulphur, but far better than those sprayed with Bordeaux. Lime sulphur is a very safe material to use for spraying all varieties. If it were certain that this material would control the Illinois and New York cankers, which chiefly attack the trunk and branches of trees, and the apple blotch

which attacks both the twigs and fruit, there would be little excuse for using Bordeaux mixture outside of the region where bitter rot is prevalent.

The average cost of spraying this orchard twice with lime sulphur, including both materials and labor, amounted to 12.6 cents per tree, or \$7.56 per acre. The average for Bordeaux was 12.1 cents per tree, or \$7.26 per acre. The average for all materials and varieties show the net profits due to spraying were \$76.78 per acre.

The Loren P. Withers Orchard (Monett, Barry County). This was one of the advisory orchards where the owner did all of the spraying himself by following the directions supplied him. The orchard consisted mostly of Gano, but included several other varieties. A block of sixty trees was set apart for the spraying test. The trees were of all ages, being from 5 to 25 years old. A power spraying outfit was used. Applications were made as follows:

April 13, with Bordeaux mixture 6-8-50, plus 2½ lbs. powdered arsenate of lead;

May 3, with soluble sulphur, 1¼ lbs. to 100 gallons of water, plus 2½ lbs. powdered arsenate of lead;

May 23, with Bordeaux 4-6-100, plus 2½ lbs. powdered arsenate of lead.

On July 1, notes were taken by counting the apples on one tree of Delicious and one of Senator. There was 4.7 per cent of scab on the former and 12.2 per cent on the latter. Codling moth was entirely controlled. The curculio injury was very small, being 1 per cent on Delicious and 4 per cent on Senator. Unfortunately no check trees were left for purposes of comparison.

The spraying cost was 16.3 cents per tree, or \$9.78 per acre. Since there were no check trees, no figures are available showing the profits due to spraying. However, the owner of the orchard was well pleased with the results, and will continue to spray hereafter.

REVIEW OF SPRAYING RESULTS

Comparison of Lime Sulphur and Bordeaux. In all of the orchards throughout the state included in the demonstration work, the spray materials used, with one exception, were lime sulphur and Bordeaux mixture with arsenate of lead as the insecticide. Since both lime sulphur and Bordeaux are standard spraying solutions, the results obtained from using each will be of interest. Table 35 shows the results secured from using lime sulphur and arsenate of lead in the different orchards where figures are available. These figures show the full effects of the spraying as when the notes were taken in early summer none of the apples affected with insects or diseases had yet fallen off.

Table 35—Summary of Results from Spraying with Lime Sulphur
and Arsenate of Lead up to Early Summer

Orchard	Treatment	Percentage insect, disease and spray injury			Percentage of unblemished fruit
		Disease injury	Insect injury	Spray burn or russeting	
Bland Orchard Co., Lebanon	Sprayed	4.9	1.1	1.3	91.9
	Unsprayed	86.5	7.7	0	5.2
H. S. Branaman, Rushville	Sprayed	0	15.6	0.8	83.4
	Unsprayed	1.1	86.4	0	17.1
J. G. Dameron, Hannibal	Sprayed	0	5.0	0	94.8
	Unsprayed	1.7	89.6	0	10.0
G. W. Davis, Independence	Sprayed	0.6	3.8	5.0	90.8
	Unsprayed	11.0	27.5	0	62.6
P. R. Jaeger, Boonville	Sprayed	1.7	6.5	1.0	89.3
	Unsprayed	29.6	53.1	0	17.3
Kelsey Orchard Co., St. Joseph	Sprayed	0	9.5	0	90.5
	Unsprayed	0	44.6	0	53.4
J. S. Livesay, Independence	Sprayed	0.6	8.2	0	91.2
	Unsprayed	4.8	90.4	0	9.6
G. K. Murray, Willard	Sprayed	1.1	2.3	2.4	81.8
	Unsprayed	56.8	8.2	0	11.7
F. F. Osterloch, Hartsburg	Sprayed	0.4	14.8	0	85.0
	Unsprayed	0	56.5	0	46.0
C. D. Peck, Peirce City	Sprayed	0.04	0.5	3.0	91.4
	Unsprayed	19.0	24.4	0	46.5

Table 35—Continued

Orchard	Treatment	Percentage insect, disease and spray injury			Percentage of unblemished fruit
		Disease injury	Insect injury	Spray burn or russetting	
J. E. Roberts, Maysville	Sprayed	0	6.1	0	91.1
	Unsprayed	2.8	63.6	0	33.3
A. E. Rose, Republic	Sprayed	8.7	14.3	0	79.1
	Unsprayed	38.2	20.8	0	36.4
Turner Station Orchard, McBaine	Sprayed	2.26	2.9	0.14	90.2
	Unsprayed	14.5	34.7	0	54.0
Average	Sprayed	1.56	6.97	1.05	88.5
	Unsprayed	20.4	46.7	0	31.0

As might be expected, the results vary considerably. Insects and diseases were worse in some localities than others. Also there were great differences in the spraying outfits used. Sometimes, too, the spraying was done by persons who had done little or no spraying before; also weather conditions are often unfavorable for doing thorough work. When the spraying was done right, the results were always good. Note the average results of sprayed, as compared with unsprayed trees, at the close of the table.

In Table 36 are shown the results of spraying with Bordeaux where notes were taken in early summer just after the "June drop" was over.

While the two orchards mentioned in the last table were located in widely separated localities (the former in Lawrence and the latter in Boone County), the results were very similar. This was because prevailing conditions in the two places at spraying time happened to be very much alike.

For convenience in making comparisons, the average results for both lime sulphur and Bordeaux are shown in Table 37.

At first glance it would seem that lime sulphur was more effective than Bordeaux in controlling diseases, but by reference to the un-

Table 36—Summary of Results of Spraying with Bordeaux Mixture and Arsenate of Lead up to Early Summer

Orchard	Treatment	Percentage insect, disease and spray injury			Percentage of unblemished fruit
		Disease injury	Insect injury	Spray burn or russetting	
G. V. Kline, Peirce City	Sprayed	0	3.0	80.0	2.4
	Unsprayed	18.2	31.6	0	23.5
Turner Station Orchard, McBaine	Sprayed	3.76	5.04	50.0	37.02
	Unsprayed	14.5	34.7	0	54.0
Average	Sprayed	1.88	4.02	65.0	19.71
	Unsprayed	16.35	33.15	0	38.75

Table 37—Comparative Results from Spraying with Lime Sulphur and Bordeaux up to Early Summer

Material	Treatment	Percentage insect, disease and spray injury			Percentage of unblemished fruit
		Disease injury	Insect injury	Spray burn or russetting	
Lime Sulphur	Sprayed	1.56	6.97	1.05	88.5
	Unsprayed	20.4	46.7	0	31.0
Bordeaux	Sprayed	1.88	4.02	65.0	19.71
	Unsprayed	16.35	33.15	0	38.75

Table 38—Summary of Figures Taken at Harvesting Time Showing Comparative Average Results Secured From Using The Different Spraying Materials

Material	Percentage of disease injury		Percentage of insect injury		Percentage of spray injury	
	Up to early summer	Harvesting time	Up to early summer	Harvesting time	Up to early summer	Harvesting time
Bordeaux (7 orchards)	1.88	4.5	4.02	6.25	65.0	88.2
Lime sulphur (13 orchards)	1.56	11.78	6.97	30.35	1.05	3.94
Soluble sulphur (1 orchard)	1.1	0.6	2.7	3.3	1.25	5.1
Prepared Bordeaux (1 orchard)	2.9	8.0	10.8	8.9	58.2	87.8

Table 38—Continued

Material	Percentage of disease injury		Percentage of insect injury		Percentage of spray injury	
	Up to early summer	Harvesting time	Up to early summer	Harvesting time	Up to early summer	Harvesting time
Arsenate of lead (1 orchard)	5.7	7.2	4.7	13.6	35.4	93.0
Pyrox (1 orchard)	0.8	4.2	9.2	41.2	60.0	40.0
Check (unsprayed) (16 orchards)	26.5	52.1	37.03	59.6	0	0

sprayed trees it will be seen that diseases happened to be more abundant in the orchards that were sprayed with the lime sulphur. If we take the ratio between sprayed and unsprayed orchards in each case, the following approximate results are secured:

Lime sulphur, diseases 1 to 14; insects 1 to $6\frac{1}{4}$.

Bordeaux, diseases 1 to 16; insects 1 to $8\frac{1}{2}$.

Apparently then, lime sulphur and arsenate of lead were more efficient in controlling diseases and insects than Bordeaux and arsenate of lead.

Comparison of Six Different Spraying Materials. Several different materials were used on a commercial scale in the Turner Station orchard. It will be of interest to compare these with lime sulphur and Bordeaux as regards their efficiency. Table 38 shows the results secured from using the different sprays (the insecticide being the same in all cases) at the two note-taking periods,—early summer and harvesting time.

These results require considerable discussion. In the first place the figures would seem to indicate that the good effects of the Bordeaux spray in protecting the fruit from diseases were offset by the high percentage of the apples injured by the spray itself. However, the real injury was not as bad as the figures appear to show. In taking the notes if there was the least trace of russetting on the apple this was counted as spray injury. While even a slight amount of russetting might mar the appearance of a green, yellow or white skinned apple, it requires very severe burning to seriously injure the sale value of red apples. The worst spray burn observed was on Gano and Jonathan, both red varieties. However, these varieties took on such a deep red color before harvesting that much of the russetting was obscured. This was particularly true of the Jonathan in the main orchard sprayed with Bordeaux. The Gano sprayed with Bordeaux were very badly russeted and, in the main orchard sprayed, the trees had rather dense heads and the foliage was especially heavy. On account of being shaded, many of the apples did not color properly and consequently the russetting caused quite a number —perhaps 10 per cent—to go into the second grade. Briefly summed up, it may be said that the serious burning of the fruit from the Bordeaux spray probably amounted to about 10 per cent instead of 53.1 per cent as shown in Table 38.

Results from Lime Sulphur Spray. The lime sulphur spray caused no injury of any consequence to either the fruit or leaves. The 11.78 per cent of disease injury was due to the fact that three of the worst scab infected orchards of the season were sprayed with lime sulphur. The high percentage of insect injury (30.35) was

due to poor results secured in two or three small orchards where the calyx spray was very improperly applied. On the whole where conditions were comparable, the lime sulphur and arsenate of lead protected fruit and foliage as well as Bordeaux and arsenate of lead.

Results from Soluble Sulphur Spray. Fortunately the soluble sulphur spray was applied but twice and caused but slight injury to the fruit. However, the second application (calyx spray) did injure the leaves very seriously. Practically every leaf that was half-grown or larger at the time of spraying, dropped off within the next two or three weeks. The trees themselves would have been seriously hurt had they not been young and in a vigorous state of growth. Old trees never would have survived losing almost an entire crop of leaves in May without being left so weak that they easily would have fallen victims to canker attacks, or died during the drought which followed later in the summer. At Lebanon and other places where trees were sprayed three times with the soluble sulphur, there was serious injury to the calyx end of the apples and such fruit was entirely ruined.

Results from Prepared Bordeaux. The prepared Bordeaux (in the form of a paste to be added to water) caused more russetting of the fruit than the regular Bordeaux. The leaves also showed some scorching from the spray. While much of the fruit colored so well that the russetting was obscured, fully 10 per cent was reduced from the first to the second grade on account of the spray injury. The variety was Jonathan. Had Gano been sprayed with this material the damage would have been very serious indeed.

Results From Arsenate of Lead Paste. A trial acre of Jonathan trees was sprayed with arsenate of lead paste alone. In this particular orchard, on unsprayed trees, the early summer notes showed 12.7 per cent of disease injury, and at harvesting time there was 14.6 per cent. It would thus appear that the arsenate of lead reduced the diseases (cedar rust and scab) by one-half, and that this material, therefore, has some fungicidal value. However, too much confidence should not be placed in these figures. It will be noticed that the spray injury from using this material amounted to 87.8 per cent at harvesting time. Now every experienced orchardist knows that arsenate of lead paste will not russet Jonathan apples to any great extent. It is, therefore, very probable that both the good effects in controlling diseases and the bad results of russetting were caused by Bordeaux, as the previous tank of spray material was Bordeaux which was applied to an adjoining plat, and it is quite possible that enough remained in the tank to produce the results

mentioned. With this explanation, the figures are submitted for what they are worth.

Results From Pyrox Spray. Pyrox is a material that very much resembles prepared Bordeaux (Bordeaux arsenate) in that it is in the form of a paste which is added to water. Pyrox seemed to control cedar rust better than anything else used. The block of trees sprayed with pyrox showed a very high percentage of curculio injury. The probable explanation for this is, as mentioned elsewhere, that the plat was located immediately adjacent to a body of timber land where there were crab apple and haw bushes, natural breeding grounds for curculio.

Unless one has only a very few trees, certainly not over an acre, and does not care to go to the trouble of making Bordeaux, there seems to be little excuse for using either prepared Bordeaux or pyrox as they are more expensive than Bordeaux and not any more efficient for spraying purposes. The chief difficulty with prepared materials like these is that it is impossible to regulate the amount of the insecticide used at each application. For example when making the cluster spray it is rarely necessary to use any poison at all, and for the calyx spray an extra amount is needed.

Net Effect of Spraying. For the purpose of determining the total net effects of the spraying for the entire season, an average was taken of all orchards regardless of materials used. This summary is given in Table 39.

Table 39—Summary of Spraying Results for all Orchards and all Materials
for the Season of 1914.—Harvesting Data

Treatment	Percentage insect, disease and spray injury						Value fruit per acre	Profit due to spraying
	Worms	Curculio	Rots	Scab	Cedar rust	Spray injury		
Sprayed	9.9	10.3	2.4	6.4	1.5	25.5	\$187.19	\$143.03
Unsprayed	50.3	28.8	14.0	32.1	1.1	0	18.05	0

The above figures are valuable because they represent the average results from spraying a large number of orchards under widely varying conditions. While the percentage of insects seems high where spraying was done, a glance at the column of fruit values shows that even though the fruit may not be entirely protected from diseases and insects, that spraying nevertheless, is quite profitable.

COST OF SPRAYING

Cost of Lime Sulphur Spray. Table 40 shows the cost of spraying with lime sulphur in the different orchards.

In practically every instance where lime sulphur was employed it was used at the regular strength of 3-100 (3 gallons of the commercial lime sulphur to 100 gallons of water). The spraying plan called for a diluted solution with a specific gravity of 1.009. The required spraying strength was obtained by testing the concentrated liquid fresh from the barrel with a Bausch & Lomb orchardists' hydrometer. If this test showed a specific gravity of 1.270 (as it usually did), when 1.009 was wanted, the amount of water to use per gallon of the lime sulphur in order to secure the latter strength was determined by dividing the fraction of the former number by the fraction of the latter, thus: $.270 \div .009 = 30$. This means that the dilution was 1 to 30, or approximately 3 to 100. This strength was used for all applications. Arsenate of lead was used at the rate of three to six pounds per hundred gallons of liquid for all applications, except the cluster spray.

The cost of spraying varies greatly. The principal factors affecting cost are: Size of trees, thoroughness of application, kind of nozzle used, light or heavy bloom or set of fruit and weather conditions at spraying time—that is, whether windy or calm. The first application (the cluster spray) is made before the leaves are out, with a nozzle that forms a fine misty spray. This does not require much time or material and hence this is usually the least expensive application. If there is a good bloom, the second or calyx spray is the most expensive application as a coarse nozzle is generally used and the spray must be directed at each separate cluster of calyx cups, and the latter penetrated and filled which can be accomplished well only under high pressure from the pump. The cost of the third application ordinarily is about the same as the first, but this depends entirely upon how well the fruit sets. The same is true of the fourth application. Both the third and fourth applications are made with a nozzle throwing a fine misty spray which covers fruit and leaves with a fine film of the liquid.

Table 40—Cost of Spraying Apple Trees with Lime Sulphur and Arsenate of Lead

Orchard	Total cost of each application, per tree, including labor, teams and spraying materials.					Age of trees	Number of trees sprayed
	First application	Second application	Third application	Fourth application	Average cost per application		
	cents	cents	cents	cents	cents	years	
Bland Orchard Co., Lebanon	6.0	12.0	10.5	0	9.5	20	37
H. S. Branaman, Rushville	7.4	21.2	14.0	9.2	12.9	17	117
J. C. Dameron, Hannibal	4.0	14.0	0	0	9.0	15	40
G. W. Davis, Independence	7.0	31.2	8.4	0	15.5	20	12
E. E. Greenwade, Willard	8.4	8.8	7.6	7.7	8.1	25	70
P. R. Jaeger, Boonville	17.	23.4	16.5	0	18.9	18	31

Table 40—Continued

Orchard	Total cost of each application, per tree, including labor, teams and spraying materials.					Age of trees	Number trees sprayed
	First application	Second application	Third application	Fourth application	Average cost per application		
	cents	cents	cents	cents	cents	years	
Kelsey Orchard Co., St. Joseph	4.5	12.5	10.0	5.1	8.0	12	89
J. S. Livesay, Independence	3.4	12.4	8.4	0	8.0	10	44
G. K. Murray, Willard	8.0	14.5	8.4	8.0	9.7	15	50
F. F. Osterloch, Hartsburg	10.0	7.5	8.0	0	8.5	18	54
C. D. Peck, Peirce City	8.7	5.6	4.9	4.0	5.8	20	110

Table 40—Continued

Orchard	Total cost of each application, per tree, including labor, teams and spraying materials.					Age of trees	Number trees sprayed
	First application	Second application	Third application	Fourth application	Average cost per application		
J. E. Roberts, Maysville	cents 6.0	cents 13.1	cents 16.0	cents 0	cents 11.7	years 28	9
A. E. Rose, Republic	6.4	17.5	9.2	0	11.3	23	26
Turner Station Orchard, McBaine	6.1	6.5	0	0	6.3	11	226
Average for 14 orchards	7.1	13.8	9.4	6.8	9.2	18	Total No. 915
Cost per acre (sixty trees)	\$4.26	\$8.28	\$5.64	\$4.08			

Table 41—Cost of Spraying Apple Trees with Bordeaux Mixture and Arsenate of Lead

Orchard	Total cost of each application, per tree, including labor, teams and spraying materials:					Age of trees	Number trees sprayed
	First applica-tion	Second applica-tion	Third applica-tion	Fourth applica-tion	Average cost per applica-tion		
D. E. Brite, Monett	cents 7.8	cents —	cents 6.4	cents —	cents 7.1	years 20	50
E. E. Greenwade, Willard	—	—	—	9.2	9.2	25	70
Roy Jackson, Republic	—	—	—	10.0	10.0	25	47
Dr. E. L. Johnston, Waverly	—	—	—	14.0	14.0	20	66
G. V. Kline, Peirce City	2.6	6.8	4.6	4.0	4.5	11	35

Table 41—Continued

Orchard	Total cost of each application, per tree, including labor, teams and spraying materials:					Age of trees	Number trees sprayed
	First applica- tion	Second applica- tion	Third applica- tion	Fourth applica- tion	Average cost per applica- tion		
Lebanon Orchard Co., Lebanon	cents	cents	cents	cents	cents	years	
	—	—	—	9.5	9.5	18	36
Turner Station Orchard, McBaine	6.2	5.9	—	—	6.05	11	333
Average for 7 orchards	5.5	6.35	5.5	9.34	6.67	18.5	Total No. 637
Cost per acre (sixty trees)	\$3.30	\$3.81	\$3.30	\$5.60			

The summary of 14 orchards shows that the average cost of the different applications of lime sulphur were: First, 7.1 cents; second, 13.8 cents; third, 9.4 cents; and fourth, 6.8 cents.

Cost of Bordeaux Mixture. Table 41 shows the cost of spraying with Bordeaux mixture. Only two orchards were sprayed entirely with Bordeaux. The fourth application, as a protection against bitter rot, was made with this material in several other orchards.

Bordeaux mixture was generally used at the following strengths: For the first application, 6-6-100 (6 lbs. copper sulphate, 6 lbs. lime to 100 gals. of water); calyx spray or second application, 3-5-100 (3 lbs. copper sulphate, 5 lbs. lime to 100 gals. of water); third application, when made, 8-8-100; and fourth application, 10-10-100. In all but the first application, arsenate of lead was used in quantities varying from three to six pounds per hundred gallons of liquid.

The average cost, per application, was: First, 5.5 cents; second, 6.35 cents; third, 5.5 cents; and fourth, 9.34 cents.

For convenience in making comparisons of cost of the two materials, the figures for both lime sulphur and Bordeaux are shown in Table 42.

The above figures show that the total cost for four applications of lime sulphur was 37.1 cents per tree, while four applications of Bordeaux cost only 26.69 cents. The average cost per application in the first case was 9.29 cents while in the second it was 6.67 cents.

In order to make the figures better understood, a comparison of the cost of spraying with lime sulphur and Bordeaux is given on an acre basis in Table 43.

The figures in Tables 42 and 43 give some idea of the cost of spraying apple trees. While it appears that it would, on the average, be \$1.56 an acre cheaper, per application, to use Bordeaux mixture, this is not necessarily true. Bearing all the conditions in mind, it is probable that the figures given in the last column for lime sulphur are a bit higher than usual, and those for Bordeaux a little lower. It is true that the average age of the trees is about the same in both cases, but it so happened that the trees in at least two of the orchards sprayed with lime sulphur were unusually large for their age, and set a tremendously heavy bloom. Some of these trees required from 18 to 20 gallons of liquid per tree for the calyx spray. (Tables 3 and 4.)

On the other hand the trees in one of the principal orchards sprayed with Bordeaux were small for their age. (Tables 19 and 20.) Also an insufficient number of orchards were sprayed with Bordeaux to make the cost data entirely comparable with the lime sulphur figures.

Table 42—Comparative Cost of Spraying with Lime Sulphur and Bordeaux, Per Application, Per Tree

Material	Total number of trees sprayed	Average age of trees	Average cost of each application, per tree:				
			First application	Second application	Third application	Fourth application	Average cost per application
Lime Sulphur	915	years 18	cents 7.1	cents 13.8	cents 9.4	cents 6.8	cents 9.29
Bordeaux	637	18.5	5.5	6.35	5.5	9.34	6.67

Table 43—Comparative Cost of Spraying With Lime Sulphur and Bordeaux on An Acre Basis

Material	Total number of trees sprayed	Average age of trees	Average cost of each application, per acre:				
			First application	Second application	Third application	Fourth application	Average cost per application
Lime sulphur	923	years 18	\$4.26	\$8.28	\$5.64	\$4.08	\$5.56
Bordeaux	538	18.5	\$3.30	\$3.81	\$3.30	\$5.60	\$4.00

SUMMARY

In 1913 five co-operative orchards were sprayed by the University of Missouri. Sixteen demonstrations were held attended by 125 people. One demonstration orchard returned an average net profit of \$161.12 per acre due to spraying.

In 1914 twenty-five orchards were sprayed, or supervised, and between seventy-five and one hundred demonstrations held. Several orchards showed a net profit, due to spraying, of \$300 to \$400 per acre.

Each demonstration orchard was sprayed from two to four times. Neighboring orchard owners were always invited to attend the demonstrations. Between 150 and 200 interested growers followed the spraying operations throughout the season, and observed the results at harvest time.

At almost every point where a demonstration orchard was located, from one to a dozen farmers were regularly advised about the management of their fruit trees and vines. Directly and indirectly, between 250 and 300 orchard owners were under the immediate influence of the University of Missouri.

With one exception all of the demonstration orchards were sprayed during the spring and summer with the two standard solutions, Bordeaux mixture and lime sulphur to control diseases, with arsenate of lead added to poison the insects.

Lime sulphur and Bordeaux, on the average seemed to be equally efficient in controlling apple scab, blossom end rot (black rot) and cedar rust. The cost of spraying with lime sulphur was 9.29 cents per tree for each application, counting all expenses including the necessary poison. The cost of Bordeaux was decidedly less, being 6.67 cents per tree, per application. (Table 42.) The total average cost of spraying with lime sulphur was \$5.56 per acre (of 60 trees) while Bordeaux cost \$4.00 per acre. (Table 43.)

The dry or powder form of arsenate of lead appeared to give as good results as the paste when used in half the quantity by weight. The powder costs approximately twice as much per pound as the paste.

While Bordeaux mixture is a reliable fungicide for all preventable orchard diseases, it is a hazardous material to use for the calyx spray, especially on varieties of the Ben Davis type and those having a light-colored skin, on account of the serious injury from spray burn which may occur.

Soluble sulphur as at present found on the market is a dangerous material to use as a summer spray. It is very apt to destroy the

leaves, and may kill the calyx of the apples, thus causing the fruit to decay. The soluble sulphur seems to set free a large amount of arsenic from the arsenate that must be used with it as an insecticide, and it is this that causes the injury.

Soluble sulphur, while unsafe to use as now made, is a promising spray material. Two applications during the season of 1914 on Gano produced fruit with a lustre or finish that even lime sulphur could not give, but fully 75 per cent of the leaves were caused to drop off. Where three applications were given, from 10 to 25 per cent of the fruit was destroyed.

Bordeaux arsenate (prepared Bordeaux) and pyrox are both good fungicides and insecticides, but both are apt to burn the fruit, especially the Ben Davis and Gano varieties. Both are handy to use where only a few trees are to be sprayed, but on a commercial scale Bordeaux would be more satisfactory and less expensive.

Missouri orchardists are advised to spray their apple trees at least three times; before blooming, immediately after blooming, and ten days to two weeks later. For the first spray use lime sulphur 3 gallons to 100 gallons of water or, Bordeaux 6-6-100 (6 lbs. copper sulphate, 6 lbs. fresh lime, 100 gals. water); second spray, lime sulphur 3-100, plus 5 lbs. arsenate of lead paste; third, same as second, or Bordeaux 6-6-100, plus 5 lbs. arsenate of lead paste. Where bitter rot is bad, one or two more applications may have to be made with either lime sulphur or Bordeaux.

The cost of spraying, season of 1914 (average of all orchards and all materials used) was as follows:

First application, 6.6 cents per tree, or \$3.96 per acre.

Second application, 13 cents per tree, or 7.80 per acre.

Third application, 9.5 cents per tree, or 5.70 per acre.

Fourth application, 8. cents per tree, or 4.80 per acre.

Cost of spraying twice, 19 cents per tree or 11.76 per acre.

Cost of spraying three times, 29.1 cents per tree or \$17.46 per acre.

Cost of spraying four times, 37.1 cents per tree or \$22.26 per acre.