
MISSOURI

Agricultural College Experiment Station.

BULLETIN NO. 27.

SPRAYING APPLE TREES

FOR

Destruction of Insects, and Prevention of Fungous Diseases.

COLUMBIA, MISSOURI,

OCTOBER, 1894.

E. W. STEPHENS, Printer, Columbia, Mo

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INTRODUCTORY.

In carrying out the objects of the organization of an "Agricultural Experiment Station," we cordially invite the co-operation of all persons interested in its success. Suggestions as to lines of experimental work, problems to be solved, inquiries relating to agriculture, horticulture, stock and the dairy will be cheerfully received and answered as far as possible; but no work will be undertaken unless of public value, and the results of which we are at liberty to use for the public good.

Specimens of grains and grasses; seeds of fruit and forest trees; vegetables, plants and flowers that are true to name; varieties of beneficial and injurious insects; samples of mineral waters and ores, and whatever may illustrate any department of agriculture will be gladly received and due acknowledgments made in annual reports. Directions for collecting, packing and shipping such specimens will be furnished on application.

Bulletins will be issued, giving the results of experimental work as fast as completed, together with such suggestions and information as may be thought valuable to the farmers of Missouri.

The bulletins and reports of this Station are sent free to every citizen of Missouri who applies for them. Copies are sent as soon as issued to every newspaper in the State, to every Grange, Farmers' Alliance or other agricultural organization whose address can be obtained. Bulletins and reports are also sent to the leading agricultural papers of the country, and will be sent to *any* paper that may desire to exchange.

Letters relating to any special line of work should be directed to the officer in charge of that division, but all general correspondence relating to the work of the Station should be addressed to

EDWARD D. PORTER,
Director of Experiment Station.

COLUMBIA, Boone County, Mo.

SPRAYING APPLE TREES.

CHARLES A. KEFFER, *Horticulturist*.

The principal experimental work of this department during the past season has been in the use of Bordeaux Mixture as a preventive of apple scab. This disease is so universal as scarcely to warrant a description. It enters the apple trees in the early spring, by the sprouting of tiny spores, which endure through the winter, attached to the bark and the *debris* beneath orchard trees. Once the fungus has gotten beneath the bark or the epidermis of the leaves, it can not be killed by any application we can make. But the spores themselves are killed by contact with salts of copper. The presence of the disease is not suspected until it appears in the form of dark or black spots on the fruit, and slightly raised dark discolorations of the leaves. In the fruit the disease checks the growth of the parts affected, and when the scab is very bad the fruit becomes misshapen and does not develop. The leaves become wrinkled and slightly curled, and in July and August the trees often look as though their foliage were blighted. While the damage done the fruit is immediate and easily seen, the greater injury which the trees suffer, resulting as it does from defective foliage and consequent interference with assimilation, is at first not apparent and not appreciated. When it is remembered, however, that the vigor of growth and general healthfulness of the

tree is directly dependent upon the perfection of its working organs,—roots and leaves; that the material of all plant tissues is made in the leaf during sunshine, and diffused to the growing parts thereafter, and that the fruit buds of one year are all started the year previously, the direct necessity for healthy leaves becomes more apparent. The importance of keeping the trees free from scab during “off” years, is thus seen to be quite as great as the protection of the fruit itself.

The spores (seed) of apple scab remain dormant through winter, attached to decayed and dried fruit, leaves, and the bark of trees. As in the case of the seeds of flowering plants, warmth and moisture are necessary for the sprouting of the spores. They are so small as to be invisible to the naked eye, and they germinate very early, even before the leaf buds of the apple burst. They can only germinate in moisture, but the merest film of water is sufficient, hence the dew furnishes water enough for the development of the spores. If a spore has happened to become attached to a bud, when it sprouts, the tiny thread which corresponds to the shoot from a seed, grows among the opening bud scales until it penetrates to a young leaf, which it enters and is then safe to complete its round of life.

Bordeaux Mixture is a preparation of sulphate of copper (bluestone or blue vitriol) and lime, the copper being the remedial agent. It is applied to the tree in the form of fine spray, which should reach every part of the tree. The spray dries very soon after it comes in contact with the tree, and has considerable tenacity, quite a heavy rain being required to wash it all off. In its dry form, the mixture is valueless, but the same dew that is necessary for the germination of the scab spore, will dissolve a small part of the Bordeaux Mixture sufficient to kill the spore and thus prevent infection. This being understood, it

only remains to keep the orchard always sprayed in order to protect it from this very common and injurious fungus.

The lime which forms a part of Bordeaux Mixture, though of no remedial value, performs a very important function. It protects the foliage from injury that would result from the application of copper sulphate solution, and it makes the fungicide stick better, thus lessening the number of applications.

FORMULÆ FOR BORDEAUX MIXTURE.

The experiments on which this bulletin are based, had for one object the determination of the best proportion of blue vitriol and lime to use in making Bordeaux Mixture. The original formula for Bordeaux Mixture was six pounds blue vitriol, six pounds lime and twenty-two gallons water. Experiment proved this to be a stronger solution than is necessary. In this year's work, three formulæ were used, as follows:

- | | |
|-----------------|--|
| No. 1..... | Six pounds blue vitriol. Four pounds lime. Fifty gallons water. |
| No. 2 | Four pounds blue vitriol. Two and two-thirds pounds lime. Fifty gallons water. |
| No. 3..... | Two pounds blue vitriol. One and one-third pounds lime. Fifty gallons water. |

In all cases the method of preparation was as follows:

The vitriol was tied in a piece of coarse sacking and suspended (not covered) in a tub containing eight or ten gallons of water, two or three days before the mixture was to be used. The time required for the vitriol to dissolve depended upon its fineness, so it was usually pulverized before being put to soak.

When the vitriol was all dissolved, the lime was slacked in a bucket of water and strained through a sieve

or burlap, into the vitriol solution, which had been poured into the spraying tank—a fifty gallon barrel.

After trying several ways of dissolving the vitriol, and making the mixture, this was found to be most convenient.

Hard lime only should be used, as air slacked lime does not make the mixture adhere as well.

Where time is limited the vitriol may be dissolved quickly by suspending it in boiling water.

Where but few trees are to be sprayed, the relative proportions can be easily determined.

METEOROLOGICAL DATA.

The accompanying table gives facts regarding temperature, rainfall and cloudiness during the growing season.

The weather has a very important effect on diseases of the apple. During a warm, moist season, the scab grows much more rapidly than during a dry season. In such years it not infrequently entirely destroys the crop, and the same is true of the bitter rot, which does not make itself known until the fruit has almost gained its growth, and which develops most rapidly toward the ripening time.

The year has been one of the dryest in the history of the West. The average rainfall at Columbia from January to September inclusive, as recorded by the Weather Service, has been 33.60 inches for the past five years. This year it has been 25.10 inches, or 8.50 inches less than the normal. The heat has been very great, but owing to the drouth, scab and rot have not been as bad as usual.

Four sprayings were found to be sufficient; the foliage has never been free from Bordeaux Mixture, easily seen throughout the season. At this date (Sept. 23d), spray applied in Mr. McIntyre's orchard June 28th, is plainly visible. Last year, in the vineyard, six applications failed to be as beneficial as four this year.

The time of heaviest rain should be noted in connection with the date of spraying. Once the spray is thoroughly dried on the leaves a heavy rain is required to wash it off.

Following is the table:

| MONTH. | TEMPERATURE. | | RAINFALL. | | | | WEATHER. | | |
|-----------|--------------|-----------|-----------------------|------------------|-------|------------------------------------|----------|------------------|--------|
| | Highest | Lowest | Greatest in 24 hrs | No. days with | Total | † Above or † be- low mean | Clear | Partly Cloudy | Cloudy |
| April ... | 90 (29th) | 30 (11th) | .88 (14th) | 17 | 2.02 | 2.38† | 10 | 7 | 13 |
| May | 89 (16th) | 36 (20th) | 1.87 (9th) | 13 | 4.33 | 1.12† | 7 | 13 | 11 |
| June.... | 97 (21st) | 43 (6th) | 1.05 (25th 26th) | 12 | 3.04 | 1.25† | 15 | 12 | 3 |
| July | 105 (25th) | 50 (23d) | .74 (4th) | 9 | 1.20 | 2.96† | 14 | 11 | 6 |
| August . | 105 (10th) | 44 (4th) | .63 (20th) | 7 | 1.29 | 2.03† | 18 | 8 | 5 |
| Sept. ... | 96 (8th) | 62 (12th) | 3.84 (15th) | 11 | 6.85 | 3.40† | 5 | 9 | 7 |

THE ORCHARDS.

The apple trees in the Horticultural grounds are very old, and the orchard contains a number of varieties, with but few trees of a kind. In order to test the efficacy of the mixture on trees of different ages and condition, and to find in one block enough trees of one variety to experiment with solutions of varying strength, four different orchards were used as follows:

First.—The home orchard, numbering 112 trees, not more than ten of any one variety. This orchard has been thoroughly cultivated during the past two seasons with

the Acme pulverizer, being kept absolutely free from weeds until August, after which all large growth was cut down. The trees were thoroughly pruned last winter. Most of them are aged trees set thirty-two feet apart, the branches now almost touching. The majority of them are of low vitality, and the past very trying season has resulted in the loss of several of them. In addition to the orchard plant, a few apple trees set in grass, and a row of young trees that should bear well next year, were sprayed.

Second.—The orchard of Mr. D. A. Robnett, three miles east of Columbia. This is a commercial orchard of 160 acres, from three to six years old. The trees experimented with make three rows reaching diagonally through an orchard of sixty acres, the rows traversing a northern and a southern slope, with the intervening low land, on which the trees were smallest. The orchard did not bear this year, but it was thought that it would afford an excellent opportunity for observing the effect of spraying upon the subsequent growth of young trees. The orchard has from the first received the most intelligent and thorough cultivation, and is an excellent example of what can be done with the apple tree in this section.

Third.—Mr. J. McIntyre's orchard. Mr. McIntyre is one of the most successful apple growers in central Missouri. His first orchard was planted thirty years ago, and, as was commonly the practice at that time, it included a great many varieties. His more recent plantings consist of commercial varieties only. Eighty acres are planted with apple trees. Mr. McIntyre has followed the old time method of keeping his orchard in grass, and until the present year, he has pastured it with sheep. This year the grass has grown without hindrance, but the drouth has prevented strong growth. The trees are more

severely pruned than is commonly practiced, and only those in good ground are in vigorous condition.

The varieties sprayed in this orchard were Fameuse, Lowell, Jenneting and Willow Twig. The sprayed trees formed small blocks which were surrounded by unsprayed trees—a condition that must not be lost sight of in considering results.

Fourth.—An orchard of eighty-eight trees of Jenneting and nine trees of Ben Davis located on the College farm, was the most satisfactory place for systematic work, because the entire orchard could be sprayed, with the exception of check rows, and enough trees of a variety were available to test the various strengths of mixtures employed. This orchard has been used the past season as a hog pasture. Each tree was so protected with stakes and wire that the trunk could not be reached by the hogs. The orchard was in grass and clover sod, and afforded excellent pasturage for the hogs. The apples that dropped off were eaten by the hogs, and doubtless many worms were also destroyed.

EXPERIMENT IN HOME GROUNDS.

All of the fruit trees in the Horticultural grounds were sprayed, six different strengths of Bordeaux mixture being used: one, two, two and a half, three, four and five pounds of vitriol with two-thirds the quantity of lime to a kerosene barrel of water.

The trees sprayed, included apple, peach, pear, plum, and cherry. The apple trees used were principally aged trees, but the strongest solution was applied only to seven year old trees, none of which fruited this year. The greatest number of trees were sprayed with the three and four pound mixtures; the least with the one pound. No

apple trees were sprayed with the two and a half pound mixture. Owing to the fact that the trees sprayed included a large number of varieties, and that different varieties vary greatly in their susceptibility to scab, the work in the home ground was the least satisfactory of the year. The spraying was done on the following dates: March 21st to 23d, when winter buds of the apple had grown sufficiently to show the flower clusters, none of which had separated, the leaf buds being but little swollen: April 21st, 4 oz. paris green per barrel being added to the mixture; about one-fourth of the apple blossoms were fully open at this time. May 11th, 4 oz. paris green being added to the mixture; the largest apples were the size of small hickory nuts, and the latest (Jennetings) had just dropped their bloom. June 21st, at which time the scab showed plainly on check trees. July 21st.

The weather during the season indicated, should be noted in connection with dates of spraying. The unusually low rainfall made the sprayings less frequent than otherwise would have been necessary.

On July 5th, the fruit was gathered from two trees of Early Harvest that had been sprayed four times with four pound mixture. Tree No. 1 yielded three hundred and thirty-four fruits, of which two hundred and sixty-two were free from scab, and seventy-two were scabbed. Of the scabbed fruits forty-seven had but one scab spot, and were marketable, and only twenty-three were badly scabbed.

Tree No. 2 yielded four hundred and eighty-eight fruits, of which four hundred and twenty-five were free from scab, twenty-five showed but one scab each; seventeen were scabbed as badly as to be unmarketable; total scabbed fruits, sixty-three.

There were no Early Harvest trees in the check row, but the fruit of two unsprayed trees of this variety of

about the same vitality as ours, was gathered in Mr. McIntyre's orchard. The *two* unsprayed trees yielded as follows: of the one hundred and ninety-six fruits gathered, forty-five were free from scab, twenty-two showed one scab spot each, and ninety-two showed more than one scab spot.

Per cent. of clean fruit, sprayed, 83.5; unsprayed, 33.6.

Per cent. of scabbed fruit, sprayed, 16.5; unsprayed, 66.4.

Per cent. of salable fruit, sprayed, 92.9; unsprayed, 69.

Notes were taken on the development of scab from time to time, but the only variety which was sprayed with more than one strength of mixture, that was also represented in the farm and McIntyre's orchards, was the Jenning. Fortunately this sort is very scabby, and serves to show the effect of Bordeaux mixture, quite as well as any other. The scab was much more prevalent in the home orchard than in either of the others, despite the fact that the home orchard had been sprayed twice last year and the others not at all.

The farm and McIntyre's orchards have been in grass several years, the former being pastured with hogs, the latter with sheep. The home orchard has been well cultivated during the last three seasons, and the trees in all three cases are of about an equal vitality and age—the farm trees being a little the youngest, if there is any difference.

The condition of the crop in the three orchards as regards scab, codling moth, rot, cracking and clear (sound) fruit is shown in the following table. One-half bushel of apples were taken from the outer branches. All were picked from the northwest part of the tree, so that in the farm and home orchards, they should be equally subject to hail injury:

| | CODLING. | | SCAB. | | DRY ROT. | | BITTER ROT. | | CRACKED. | | CLEAR. | | TOTAL. | |
|---------------------------|----------|-------|-------|-------|----------|-------|-------------|-------|----------|-------|--------|-------|--------|-------|
| | OUTER | INNER | OUTER | INNER | OUTER | INNER | OUTER | INNER | OUTER | INNER | OUTER | INNER | OUTER | INNER |
| Two lb. solution. | | | | | | | | | | | | | | |
| Home | 101 | 120 | 34 | 56 | *118 | 105 | 0 | 0 | 123 | 44 | 49 | ..... | 185 | 161 |
| Farm..... | 11 | 2 | 0 | 1 | 35 | 16 | 0 | ..... | 66 | 48 | 38 | 89 | 140 | 154 |
| McIntyre..... | 34 | 24 | 39 | 45 | ..... | 9 | 1 | ..... | 37 | 7 | 95 | 98 | 176 | 178 |
| Three lb. solution | | | | | | | | | | | | | | |
| Home | 128 | 160 | 33 | 42 | 68 | 84 | 0 | 0 | 96 | 33 | 99 | ..... | 227 | 293 |
| Farm..... | 7 | 7 | 8 | 4 | 56 | 20 | 1 | ..... | 84 | 72 | 55 | 114 | 204 | 217 |
| Four lb. solution. | | | | | | | | | | | | | | |
| Home | 83 | 90 | 9 | 88 | 54 | 57 | 0 | 4 | 38 | 6 | 46 | 145 | 172 | 281 |
| Farm..... | 11 | 6 | 1 | 8 | 46 | 21 | 4 | 0 | 57 | 80 | 47 | 95 | 169 | 193 |
| McIntyre..... | 27 | 14 | 28 | 16 | 8 | 17 | 1 | 1 | 39 | 0 | 108 | 164 | 208 | 207 |
| Six lb. solution.. | | | | | | | | | | | | | | |
| Home | †6 | 6 | 4 | 2 | 31 | 24 | 4 | ..... | 55 | 33 | 41 | 87 | 139 | ..... |
| Farm..... | *4 | 6 | 22 | 17 | 2 | 12 | ..... | ..... | 81 | 8 | 95 | 191 | 202 | 234 |
| McIntyre..... | 24 | 9 | 14 | 15 | 15 | 5 | ..... | ..... | 21 | 0 | 126 | 181 | 186 | 200 |
| Unsprayed | | | | | | | | | | | | | | |
| Farm..... | 21 | 17 | 140 | 255 | 27 | 34 | 0 | ..... | 109 | 91 | 46 | 5 | 213 | ..... |
| §McIntyre | 30 | 19 | †168 | 169 | 13 | 13 | ..... | 2 | ..... | ..... | 1 | 0 | 169 | 169 |

*This tree contiguous to unsprayed row.

†This tree in third row from unsprayed row.

‡Fifty-three scab spots are old, and the remainder have appeared since the rains (see weather table).

§This check tree was sprayed once (after the bloom had fallen) by mistake.

Especial attention is called to the following points:

1. The addition of paris green does not seem to have had much effect in reducing the number of codling moth.

In the McIntyre orchard the comparison of sprayed and unsprayed trees as regards codling moth is: Sprayed, 34, 27, 24; unsprayed, 30. In all sprayings four ounces of paris green to the barrel was added.

In the farm orchard the results were somewhat better: Sprayed, 7, 11, 4, 6; unsprayed, 21. Both these orchards were used as pastures. In the home orchard where no animals were permitted the number of codling moth is very much greater, Compare the home sprayed trees with the others and this point is emphasized. The indications are that hogs and sheep are better preventives of wormy fruit than spraying with paris green.

2. The farm orchard containing but two varieties (Jenneting and Ben Davis) shows very much less scab than the home orchard, made up of many varieties, or the McIntyre orchard, in which the sprayed trees were bounded on one side by Jenneting sprayed one time, and on the other by Willow Twig sprayed four times.

3. The spraying served as a complete preventive of the autumn growing spores of scab.

4. The home and farm orchards, which were in the path of a hail storm in August, show very much more cracking and more dry rot than the McIntyre orchard, which the hail did not touch. In almost all cases the rot resulted from accidental injury. Very little bitter rot was observed.

The varying results shown in the three places served to show that conditions other than those connected with the spraying must enter largely into the determination of experiments of this kind, and seem to explain, measurably at least, the very great difference in reported results of experiments with Bordeaux Mixture.

EXPERIMENT IN THE ROBNETT ORCHARD.

This orchard is six or seven years old and is one of the thriftiest young orchards in the state. Three rows were sprayed; each containing fifty-two Ben Davis trees. Besides these, three rows of trees in a small orchard three years older were sprayed with the same strengths, two, four and six pounds of blue vitriol per barrel of mixture.

The spraying was done March 22, April 7, April 28, and June 29. At the first spraying the buds were swollen, at the second the largest leaves were one-half inch long; when the third spray was applied the trees were almost in full leaf and at the fourth spraying the growth of the season was well advanced.

But little scab was noticeable on the leaves of the trees in any part of the large orchard, and careful examinations, the last made August 8, failed to disclose any appreciable difference in the healthfulness of the foliage of sprayed and unsprayed trees. None of the young trees that were sprayed bore fruit, but several of the unsprayed trees of the same age were full. One of the eight year old Ben Davis trees in the small orchard that was sprayed fruited and on August 8 this tree and an unsprayed tree two years younger were examined for scab with the following results: On the sprayed tree (6-pound solution) there were 113 fruits, of which three were scabbed and 110 clean—2 $\frac{2}{3}$ per cent scabbed.

On the unsprayed tree there were 198 fruits, of which 73 were scabbed and 125 clean—37 per cent. scabbed, a difference in favor of spraying of 34 $\frac{1}{3}$ per cent.

This orchard should come into bearing next year, and a continuation of the experiment may bring interesting results.

EXPERIMENT IN THE M'INTYRE ORCHARD.

This is an old orchard containing many varieties of apples. Lowell, Fameuse, Jenneting and Willow Twig were sprayed, from three to five trees of each of these sorts being sprayed with two, four and six pound solutions of Bordeaux Mixture.

The spraying was done in this orchard on April 11, when the largest leaves on Willow Twig and Lowell were one-half inch long and Jenneting buds just beginning to burst; May 2, when most of the bloom had fallen; May 22, when the small fruits were yet upright on their stems; June 28, when the new growth was well advanced.

To the second and third sprays four ounces of paris green per barrel were added.

On June 2 all the fruits of Fameuse within reach of the ground were examined. On a tree sprayed with six pound solution 13 scabbed fruits were found; on a four pound tree, 35 scabbed fruits; on a two pound tree, 16 scabbed fruits; on an unsprayed tree 400 scabbed fruits.

On July 13 the trees were again examined. Two hundred fruits were counted within reach of the ground, taken as they came, starting from the outmost branch and going at least to the trunk, in order to get the shaded as well as the exposed fruits. One hundred fruits were counted in the top of the tree, where it was thought the spray had not reached as thoroughly as below. Following is the result:

Fameuse, full crop.

One tree, six pound solution, from ground 180 clean, 20 scabbed.
top 80 clean, 20 scabbed.

One tree, four pound solution, from ground 167 clean, 33 scabbed.
top 65 clean, 35 scabbed.

One tree, two pound solution, from ground 133 clean, 67 scabbed.
top 47 clean, 53 scabbed.

One tree, not sprayed, from ground 100 clean, 100 scabbed.
top 63 clean, 37 scabbed.

The same day a count of Willow Twig resulted as follows for very light crop:

- One tree, six pound solution, from ground 81 clean, 19 scabbed.
- One tree, two pound solution, from ground 66 clean, none scabbed.
- One tree, four pound solution, from ground 95 clean, 5 scabbed.
- One tree, not sprayed, from ground 87 clean, 17 scabbed.

On August 7 the Jenneting trees were examined with following results:

- One tree, six pound solution, from ground 193 clean, 7 scabbed.
top 81 clean, 19 scabbed.
- One tree, four pound solution, from ground 185 clean, 15 scabbed,
top 90 clean, 10 scabbed.
- One tree, two pound solution, from ground 71 clean, 29 scabbed.
- One tree, not sprayed, from ground 30 clean, 70 scabbed.

The Fameuse treated are the largest apple trees in this vicinity, some of them having a diameter of top of forty-five feet. It was very difficult to reach the tops of these trees with spray, and the work was not so well done as with other varieties. In order to fairly test the treatment a barrel of apples was taken from near the ground, from the check tree, and from one tree of each of the sprayed groups. The fruit was sorted for scab, the result being as follows:

- Six pound solution, clean 567, scabbed 42, dry rot 87.
- Four pound solution, clean 740, scabbed 191, dry rot 90.
- Two pound solution, clean 813, scabbed 290, dry rot 210.
- Check, clean 363, scabbed 378, dry rot 99.

In the six pound solution to which paris green was added the tree sprayed had 102 wormy apples to the barrel. On the unsprayed tree there were 123 wormy fruits to the barrel.

The unusual drouth, while it undoubtedly lessened the amount of scab, also greatly checked the growth of the fruit. Doubtless the reduction in size of fruit resulting from scab would be more apparent in a year of average rainfall.

EXPERIMENT IN FARM ORCHARD.

This orchard contained sixty-four Jenneting and sixteen Ben Davis, and was divided into five plats, the rows running east and west, as follows:

Beginning on the south side, the first four rows were sprayed with two pound solution Bordeaux mixture:

| | | | | | | | |
|--|---|-----|---|-----|----------|---|---|
| The next three rows with three pound solution. | | | | | | | |
| " | " | " | " | " | four | " | " |
| " | " | " | " | " | six | " | " |
| " | " | two | " | not | sprayed. | | |

This arrangement put the check trees contiguous to those that were to receive the strongest solution.

The first spray was applied April 16, when the winter buds were just beginning to burst. The second application was on May 7, when the Jennetings were in full bloom, and the Ben Davis past bloom. The remaining applications were made May 28, and June 22. Four ounces paris green per barrel was added to the second and third spray.

On June 4 all the fruits within reach of the ground, on trees of each section, were examined with the following result:

JENNETING.

| | | | | |
|------------|-----------------|---------|---------|---------|
| On 2 trees | 2 lb. solution, | found 2 | scabbed | fruits. |
| " 2 | " 3 " | " " | " 0 | " " |
| " 2 | " 4 " | " " | " 1 | " " |
| " 2 | " 6 " | " " | " 0 | " " |
| " 1 | " not sprayed | " 223 | " " | " " |

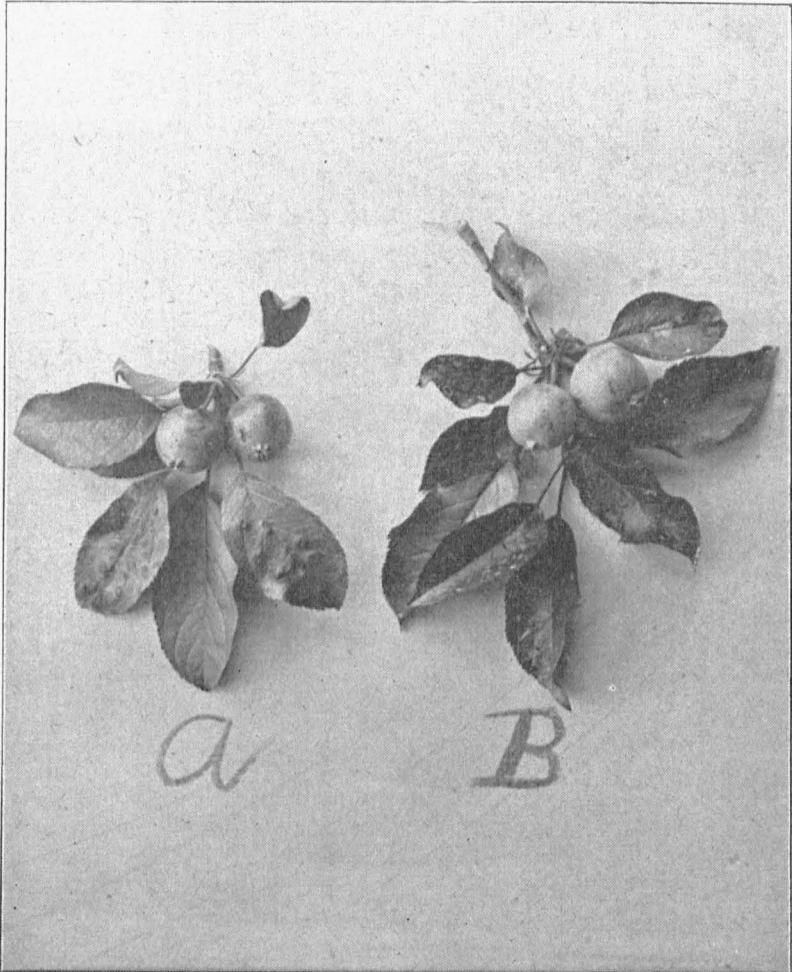
NEXT TO UNSPRAYED ROW.

On 1 tree 6 lb. solution, found 18 scabbed fruits.

BEN DAVIS.

| | | | | |
|-----------|-----------------|---------|---------|--------|
| On 1 tree | 2 lb. solution, | found 1 | scabbed | fruit. |
| " 1 | " not sprayed | " 50 | " " | " " |

June 21 a photograph was made of a branch of new growth, showing scab on leaves, and of a fruit cluster, showing scab on fruit and leaves, from which the unsprayed specimen in the accompanying illustration was taken. (A unsprayed, and B sprayed.)



At this time the scab was very bad on the leaves of Jenneting trees not sprayed, while very little could be found on the leaves of the sprayed trees, all sections seeming to be equally protected, except the row next to the unsprayed trees, which showed more scab, but little as compared with the check rows.

At the last spraying the four north and south rows on the east side of the orchard were unsprayed, thus giving double sections of Jenneting, one set with four sprays, and the other with three.

July 9 the orchard was counted in the way heretofore described, with the following results:

| JENNETING. | | | | |
|-----------------------|--------------|-------------------|-----------------|---------|
| No. of trees counted. | Solution. | Clean. | Scabbed. | |
| 4 | 2 lb. | (average) 197 3-4 | (average) 2 3-4 | ground. |
| 5 | | 100 | 0 | top. |
| 5 | 3 " | 196 3-5 | 3 2-5 | ground. |
| | | 194 2-5 | 5 3-5 | top. |
| 4 | 4 " | 195 3-4 | 4 1-4 | ground. |
| | | 198 3-4 | 1 1-4 | top. |
| 4 | 6 " | 191 3-4 | 8 1-4 | ground. |
| | | 86 3-4 | 13 1-4 | top. |
| 2 | not sprayed. | 50 | 150 | ground. |
| | | 45 1-2 | 54 1-2 | top. |

| BEN DAVIS. | | | | |
|-----------------------|--------------|--------|----------|---------|
| No. of trees counted. | Solution. | Clean. | Scabbed. | |
| 1 | 2 lb. | 200 | 0 | ground. |
| | | 98 | 2 | top. |
| 1 | 3 " | 196 | 4 | ground. |
| | | 89 | 11 | top. |
| 1 | 4 " | 198 | 2 | ground. |
| | | 89 | 11 | top. |
| 1 | 6 " | 198 | 4 | ground. |
| | | 96 | 4 | top. |
| 1 | not sprayed. | 57 | 43 | ground. |
| | | 51 | 49 | top. |

Two of the six pound trees were contiguous to the unsprayed row, which explains the greater amount of scab in this section.

A careful study of this table will show that in this orchard the two pound solution, applied to trees remote from unsprayed ones, is a better preventive of scab than a much stronger solution on trees contiguous to unsprayed rows. It also indicates that the weaker solutions are quite as safe for practical use as the stronger ones, a fact corroborated by experiments at other stations.

The excessive drouth prevented the growth of the apples, and most of the fruit is small and scarcely marketable. About half the trees in all the sprayed sections were thinned the last week in June, when the largest Jennetings were about the size of small hickory nuts. The fruit was thinned to one apple to the spur. Both the Jenneting and Ben Davis set from two to three fruits to the spur. The thinning has evidently increased the size of the fruits.

On August 13, a severe hailstorm struck the orchard, greatly injuring the apples, which showed bruised spots as the result of contact with the hailstones. About September 1 many of the apples began cracking, and this was especially noticeable where they had been injured by the hail; and the increased growth which followed the rains caused the skin to break. The Jenneting has a bad habit of cracking the skin anyway, and good growing weather following a prolonged drouth, during which the fruit developed very slowly, would necessarily increase the difficulty. The table showing the comparative conditions of the three orchards on September 24 gives a fair idea of the Jennetings at that time. On the same date the Ben Davis, examined in the same way, showed as follows:

| Solution. | Codling Moth. | Dry Rot. | Bitter Rot. | Scab. | Cracking. | Clean. | Total. |
|------------|---------------|----------|-------------|-------|-----------|--------|--------|
| 3 lb. | 37 | 12 | 1 | 7 | 0 | 64 | 119 |
| 4 " | 30 | 42 | | 5 | 7 | 84 | 161 |
| 6 " | 34 | 40 | 2 | 2 | 0 | 45 | 123 |
| Unsprayed. | 38 | 53 | | 48 | 0 | 12 | 116 |

The ultimate condition of the crop can not be determined until the fruit is gathered.

Since the above was written by Professor Keffer, the apples have been gathered and their condition noted, at the time of gathering. The object was to see whether or not the favorable condition of sprayed, as compared with unsprayed trees, which was indicated throughout the summer, continued to the full maturity of the crop.

It was found that the sprayed trees maintained the same comparative freedom from scab, indicated by the observations and countings of fruit through the summer and early autumn. It is an interesting fact that, on the "check," or unsprayed trees the *new* growth of scab continued to develop, up to the time of picking, while on the sprayed fruit not a trace of this new growth of scab was found. This fact, particularly, shows the efficacy of Bordeaux Mixture, when reference to the meteorological table tells us that the rainfall during September was 3.40 inches above the normal for that month in previous years.

As the Jennetings were the last to be picked, and, as they are also very susceptible to the ravages of apple scab, actual countings were made of this variety to show in tabular form the condition of the crop at the time of gathering (October 19 to 22).

The following table shows the percentages of clean and blemished fruit, one-half bushel being taken, just as they came from each tree.

| | Times Sprayed | Clean. | Blemished | Old Scab. | New Scab | Codling..... | Dry Rot | Cracked |
|------------------------|---------------|-------------|----------------|----------------|---------------|--------------|-----------------|-----------------|
| McIntyre— | | | | | | | | |
| Six lb. Solution . . . | 4 | 107 | 21 | 10 | 0 | 8 | 4 | 10 |
| Four lb. Solution . . | 4 | 107 | 27 | 5 | 0 | 4 | 26 | 26 |
| Check | 0 | 5 | 158 | 71 | 139 | 4 | 16 | 15 |
| Farm— | | | | | | | | |
| Six lb. Solution . . . | 4 | 49 | 188 | 0 | 0 | 5 | 76 | 112 |
| Six lb. Solution . . . | 3 | 27 | 93 | 0 | 0 | 10 | 82 | 92 |
| Four lb. Solution . . | 4 | 107 | 84 | 0 | 0 | 2 | 29 | 83 |
| Four lb. Solution . . | 3 | 27 | 93 | 0 | 0 | 10 | 82 | 93 |
| Three lb. Solution . . | 4 | 77 | 114 | 8 | 0 | 4 | 44 | 95 |
| Three lb. Solution . . | 3 | 57 | 227 | 3 | 0 | 2 | 88 | 221 |
| Two lb. Solution . . . | 4 | 121 | 61 | 1 | 0 | 11 | 23 | 41 |
| Check | 0 | 0 | 192 | 126 | 192 | 9 | 50 | 134 |

In the above table those fruits marked "blemished" include all those which were injured in anyway. The location of some of the trees, rendered them more subject to injury from the hail than were other trees. That accounts for the high proportion of "blemished" fruit in some cases. The sum of the "blemished" and "clean" fruit denote the entire number in the half bushel counted.

In almost every case dry rot set in from previous cracking of the fruit. The cracking was evidently largely due to the hail storm of August 13.

It will be noticed that, from the half bushel of apples taken from the check tree in Mr. McIntyre's orchard, 139 out of 163 were affected by new scab. Out of a half bushel taken from a a check tree on the college farm the entire 192 were thus affected. As has been before men-

tioned not a trace of this new growth of scab appeared on either of the sprayed trees, despite the unusual rainfall of September.

As the main object of the experiment was to test the efficacy of the Bordeaux Mixture, in its various strengths, in preventing apple scab, these results are very gratifying in that they plainly bespeak its beneficial effects and indicate that even the weaker solutions are effective in preventing the disease.

SUMMARY OF RESULTS.

1. The ravages of apple scab were largely checked by the use of Bordeaux Mixture.

2. This season the weaker solutions seemed to be about as effective as the stronger ones.

3. Four applications proved to be more efficacious than three.

4. The *second crop* of scab, universal on unsprayed Jennetings, was entirely prevented on sprayed trees.

5. A very small percentage of sprayed fruit was affected by the *early crop* of scab.

6. The two preceding statements, taken connectedly, would emphasize the necessity of very early spraying, since (5) the early crop of scab gained a foothold, while (4) the second crop, from spores which ripened after the trees were well covered with the copper salts, failed to establish itself on sprayed trees.

7. Nearly all the dry rot resulted from previous injury to the fruit by hail or cracking.

8. The use of Paris Green in the mixture had no appreciable effect in diminishing injury by codling moth.

9. The results obtained in the four different orchards treated were not, in all respects, parallel; hence other conditions than the mere application of the spraying mixture enter into the spraying question, and, in part, explain why varying results are reported.

10. These results were obtained in an extremely dry season, and, might have been somewhat modified, had there been the ordinary amount of rainfall.