

UNIVERSITY OF MISSOURI COLLEGE OF AGRICULTURE
AGRICULTURAL EXPERIMENT STATION

BULLETIN 161

COMBINING DORMANT AND FIRST
SUMMER SPRAY IN APPLE
ORCHARDS INFESTED BY
SAN JOSE SCALE



Fig. 1.—Apple buds ready for cluster-bud spray, April 20, 1917, Experiment Station Orchard, Columbia, Mo. Commercial lime-sulphur testing 33° Baume was applied as a spray at a dilution of 1 to 7, when the trees were at this state of development

COLUMBIA, MISSOURI
JANUARY, 1919

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Combining Dormant and First Summer Spray In Apple Orchards Infested By San Jose Scale

T. J. TALBERT

Experiments and observations extending over a period of four years have shown that the dormant or San Jose scale spray consisting of commercial lime-sulphur, testing 33 degrees Baume, may be applied to apple trees at a dilution of 1 to 7 or 1 to 8 after growth starts and until the trees begin to bloom, without material injury to leaves or flower buds. If this strong spray is applied after the leaves are out and the buds are beginning to show their petals, it takes the place of the so-called cluster-bud or first summer spray. It eliminates, therefore, the cost of labor and materials for one summer application in apple orchards infested by San Jose scale. This recommendation is contrary to those in other literature dealing with the time to spray for the control of San Jose scale. Most authorities advise that this concentrated spray be used only in the dormant period of apple trees. A few later publications state, however, that the fruit grower should wait until the buds swell or growth starts in order to obtain the best results. Yet none states that the so-called dormant spray for the control of San Jose scale may be applied to apple trees at a later stage of development, without severe injury. In fact it has been the general opinion of entomologists and horticulturists that this strong lime-sulphur solution could not be applied just before the fruit blooms appear without danger of seriously injuring the leaves and flower buds.

The fact that the lime-sulphur spray for the control of San Jose scale can be used after growth begins and up until the first blooms appear, should be of great value to fruit growers who for any reason have neglected to apply the spray at some time during the dormant season.

Since this is a new spraying schedule for the control of San Jose scale, and in view of the fact that it is contrary to all other recommendations, it is suggested that where for any reason fruit growers believe they cannot apply this spray as indicated, without injury, a test be made during one spring on a few trees before the strong

spray is applied to the whole orchard. The concentrated lime-sulphur solution in the hands of careless or inexperienced orchardists might prove unsatisfactory, hence the suggestion that a test be made on a few trees before the spray is applied generally.

The strong spray applied at the cluster-bud period is very effective in killing San Jose scale. This is especially true where thoro work is done. The bark of the infested trees is left covered with the strong spray and the young scales which are produced later have difficulty in finding suitable places to settle down and begin sucking sap.

The late concentrated spray has also been found to be of great value in controlling aphids or plant lice, oyster-shell scale, scurfy scale, Forbes' scale, spring canker worm, bud moth, and other sap-sucking and leaf-eating insects. When the spray is applied at this time it kills the insects by coming in contact with their bodies, hence the necessity of very thoro work. This strong solution is also effective in controlling apple scab and it is believed to be an important application against other fungous diseases such as Illinois canker, black rot, etc.

Commercial lime-sulphur when used at a dilution of 1 to 7 produces more burning than when used at a dilution of 1 to 8, 1 to 10, or 1 to 12. As a rule, the weaker the solution the less the burning. The difference in the caustic or burning effect, however, has been very slight, especially between the dilution of 1 to 7 and 1 to 8.

A spraying pressure of from 250 to 300 pounds is much more apt to cause injury by burning than a pressure of 200 pounds or less.

The common spray rods and nozzles were used in all the tests made. The spray guns which are now being used successfully in many commercial orchards have not been used in this experimental work.

The preceding summary of this work is based on the results obtained in four experimental apple orchards in 1914, four demonstration apple orchards in 1916, one experimental plot of apple trees in 1917, and one experimental plot of apple trees in 1918. An account of the work done, the observations made and results obtained, follows:

COMBINING CLUSTER-BUD AND SAN JOSE SCALE SPRAY, SPRING, 1914

Location of orchard	No. of trees	Age of trees	When sprayed	Material used	Outfit used	Variety
Station Orchard, Columbia	3	16 yrs.	Apr. 15 and Apr. 25	Lime-sulphur (1 to 8) (1 to 12)	Barrel pump	Ben Davis, Ingram
Greenwade Orchard, Willard	20	25 yrs.	Apr. 1	Lime-sulphur (1 to 8)	Power	Ben Davis
G. K. Murray Orchard, Willard	50	15 yrs.	Apr. 1	Lime-sulphur (1 to 10)	Power	Ben Davis, Grimes, York
P. J. Jager Orchard, Boonville	12	20 yrs.	Apr. 4	Lime-sulphur (1 to 8)	Barrel pump	Ben Davis, Jonathan

EXPERIMENT STATION ORCHARD, 1914

Three apple trees were used in the experiment. The varieties were one Ingram and two Ben Davis. The trees were not infested by San Jose scale, but they were sprayed as thoroly as if they were.

The spray material used was commercial lime-sulphur which tested 34 degrees Baume. Tree No. 1, Ben Davis, was sprayed with this mixture at a strength of 1 to 8, on April 15, 1914. Tree No. 2, Ben Davis, was sprayed on the same date with lime-sulphur 1 to 12. The weather was fair and the work was done about 5 p. m. Rain did not fall until April 27.

NOTES ON EFFECT OF SPRAY—BEN DAVIS TREES

April 17: Both Ben Davis trees showed brown or scorched leaves and presented in general a lighter appearance, due to the lime in the stronger spray on the trunk and branches of the trees.

April 20: Both trees looked much better, and a careful examination showed that only the tip-ends and margins of the smallest leaves had been burned or scorched. A great many of the smaller leaves on both No. 1 and No. 2 were wrinkled and twisted on account of the burning by the lime-sulphur. No. 1 appeared to be injured somewhat more than No. 2. No leaves were destroyed; in fact, almost all of the damage was confined to the tips and edges of the small leaves. Now and then a large leaf could be found which showed a little burning on the tip or edge.

April 24: Both trees were in full bloom. Nearly all of the petals and leaves were free from burns and brown spots, but the effect of the strong spray could still be plainly seen on limbs and

branches. A careful examination all around the trees with a hand lens showed only two or three blossoms that were damaged by the strong spray.

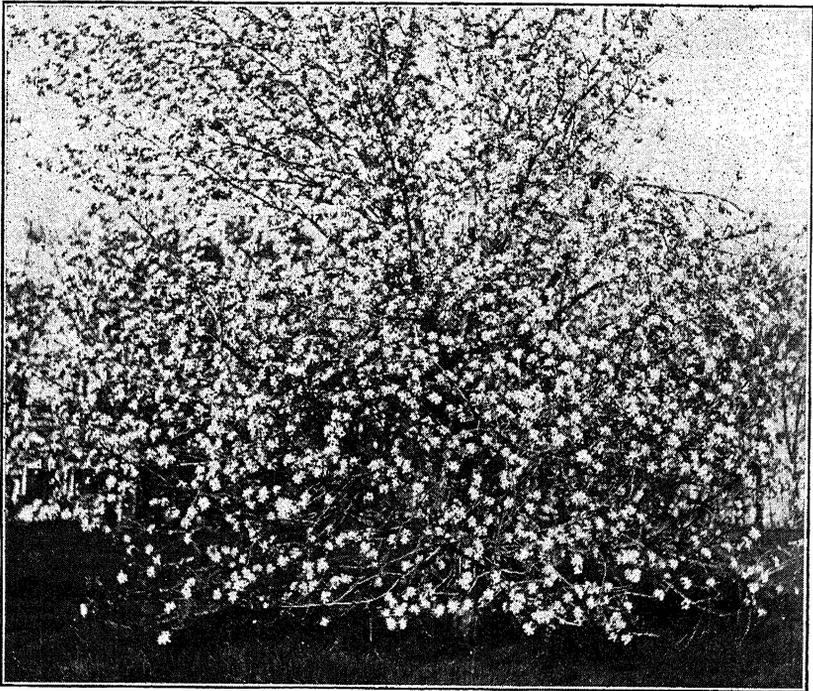


Fig. 2.—Ben Davis apple tree No. 1, Experiment Station Orchard, Columbia, Mo., as it appeared on April 25, 1914, ten days after being sprayed with commercial lime-sulphur 1 to 8

April 25: The foliage at this time, only ten days after the strong spray had been applied, showed very little injury. Very few of the leaves presented a wrinkled and scorched appearance. The plant lice were almost perfectly controlled on both trees. After the strong sprays were applied, it was difficult to find an aphid, altho they were very numerous at the time the application was made.

No. 3, the Ingram apple tree, about 16 years old, was sprayed at about 5 p. m., April 25, with commercial lime-sulphur 1 to 8. The lime-sulphur tested 33 degrees Baume. Five and one-half gallons of the dilute spray were used on the one tree.

The leaves were out and the cluster buds had separated. Nearly all of the buds showed pink and within the tree two or three of the

buds had opened and the petals showed plainly. By actual measurement many of the leaves were found to be one-half inch wide and one and one-half inches long. A barrel pump sprayer was used to give a pressure of from 80 to 90 pounds.

NOTES ON EFFECT OF STRONG SPRAY ON INGRAM TREE, No 3

The weather was bright and clear on the date the spraying was done, April 25. An examination at 10 a. m., April 26, showed that many of the flower buds had opened in the night. The stamens and pistils showed no signs of injury. The whole surface of most of the leaves showed the lime-sulphur spray very plainly. Some of the leaves were slightly crumpled and drawn due to the caustic action of the strong spray.

April 27: The examination showed more wrinkling, browning and crumpling of the leaves. The smallest leaves which were young and tender were burned the worst, especially on the tips and edges. A casual observer would not have noticed the burning on the tips and edges of the leaves. The most conspicuous thing about the tree was the white or light color due to the lime-sulphur on the trunk, limbs, branches and leaves. The entire tree appeared much as if it had received a coating of whitewash. A heavy rain fell on the night of April 27.

April 28: The lime-sulphur showed very plainly all over the tree after the heavy rain. None of the leaves were burned off. The edges and tips of some were scorched, colored brown and killed. The trees did not look severely injured and the passer-by would not have suspected that anything was wrong. A careful examination showed that not a fruit bud had been damaged. About one-third of the tree was in bloom on April 28.

May 13: Nearly all of the effects of the burning on the foliage had disappeared. On close examination, however, the edges and tips of some leaves still showed the browning and others had a wrinkled and twisted appearance. Not a fruit bud could be found that showed any injury due to the use of the strong spray.

Later observations found no injury to the fruit. In fact, the tree set more fruit than the two check trees nearby in the same plot. The second spray was applied May 13 and the tree appeared to be in splendid condition for fruiting.

GREENWADE ORCHARD, 1914

This orchard was not badly infested by the scale but all of the trees showed a scattered infestation. The twigs and fruit spurs were rather badly infested. The trees were sprayed with lime-sulphur 1 to 8, April 1. The application was made after the leaves were out, but before the cluster buds had separated. The spraying was done with a power outfit. The cluster-bud spray was omitted on the experimental plot.

Results.—No material injury was done to buds or leaves as a result of the application of the strong spray. The later summer sprayings were applied at the usual strength and very good fruit was harvested. Many of the apples were slightly blotched by the scale but this was due to inefficient work in applying the spray, owing to the use of an old and very much worn spraying outfit which furnished very poor pressure.

MURRAY ORCHARD, 1914

In this orchard 50 healthy, thrifty, 15-year-old trees were selected for the experiment. A power sprayer was used and the lime-sulphur spray was applied at a strength of 1 to 10 just as the cluster buds were separating, April 1, 1914. The trees were only slightly infested with San Jose scale. This spray was used to control the scale and at the same time take the place of the regular cluster-bud or first summer spray.

Results.—As was true in other orchards, the leaves took on a brownish or burned appearance for a few days after spraying. This color and the effect of the spray soon disappeared, and the trees in the sprayed plot fruited equally as well as the check trees. The scale was controlled perfectly and the scab was controlled equally as well as where the regular cluster-bud spray was applied. The varieties consisted of Ben Davis, Grimes, York and others.

JAEGER ORCHARD, 1914

This orchard had been badly neglected. The bark of the trees was incrustated with San Jose scale and a few trees had been killed by the pest. Very little pruning had been done and the orchard had never been sprayed.

Twelve trees were sprayed with commercial lime-sulphur 1 to 8 in December, 1913. The same trees were sprayed again the following spring, just before the blooming time. The cluster buds had

separated and many of the buds showed pink. The commercial lime-sulphur was used again at the strength of 1 to 8.

Results.—The young tender leaves were slightly burned on the tips and the opening buds took on a brownish color for a few days after spraying. No material injury was done to the developing buds and the treated trees yielded as much fruit at harvest time as the trees that were subjected to the usual treatment. The control of the scale was very good, altho there was some spotting of the fruit.

The trees were sprayed three times during the summer with a very poor barrel-pump outfit. It was impossible to do thoro work with the outfit used and no doubt this lack of thoro work accounts for some of the apples at harvest time showing quite a few scale blotches. The summer sprayings were made as follows:

April 4, with lime-sulphur 1 to 8.

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

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

On July 2, notes were taken of 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.

September 27, Mr. Jaeger reported as follows: "The block of trees under your control is doing fine and is making a nice show. Many of the trees are heavily laden with nicely colored fruit. The apples are going to be of a fine quality with the exception of many 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."

COMBINING CLUSTER-BUD AND SAN JOSE SCALE SPRAY, SPRING, 1916

Location of orchard	No. of trees	Age of trees	When sprayed	Material used	Outfit used	Variety
S. Mason, Jefferson Barracks.....	100	18 yrs.	Apr. 15	Lime-sulphur (1-7)	Power sprayer	Grimes, Wine-sap, Ben Davis, Jonathan
W. Neimer, Jefferson Barracks.....	10	20 yrs.	Apr. 14	Lime-sulphur (1-7)	Barrel pump	Jonathan, Ben Davis
Station Orchard, Columbia	6	16 to 20 yrs	Apr. 15 to 24	Lime-sulphur (1-8), (1-10), (1-12)	Barrel pump	Ben Davis, Ingram
C. Winfrey, DeWitt	3300	15 yrs.	Apr. 16 to 24	Lime-sulphur (1-7)	Power sprayer	Jonathan, Wine-sap, Ben Davis, York

MASON ORCHARD, 1916

The Mason orchard consisted of about 100 trees, 18 years old. The varieties were mixed, but the most of the trees were Winesap, Ben Davis, Jonathan and Grimes. The orchard was badly infested with San Jose scale which had never been controlled. Dormant sprays had, however, been applied every year for the last four or five years, but they were not effective in controlling the pest because the spray had not been used at the proper strength and the work had not been thoroly done.

On April 15, the apple trees were sprayed with commercial lime-sulphur at a strength of 1 to 7. The lime-sulphur tested 33 degrees Baume. At this time the leaves were out and the cluster buds had separated. Many of the buds showed the pink petals. The stage of development was just right for the first summer spray which is just before the trees bloom. The trees were sprayed very heavily; in fact, they were drenched with the strong lime-sulphur spray. From 4 to 6 gallons of the spray were used on each tree. The weather was clear and fine when the work was done.

Results.—There was a little scorching and burning on the edges and tips of the leaves. For a week or ten days after the application, the foliage on the trees appeared to be browned and scorched a little. No material injury was done. A careful inspection ten days later showed that the strong spray had done practically no damage to the leaves or developing buds. Not a single bud could be found that had been killed.

San Jose scale was never controlled better on apple trees. A hail storm about the first of July destroyed almost the entire fruit crop in this orchard. What fruit remained on the trees, however, was free from scale and apple scab injury.

NEIMER ORCHARD, 1916

Ten trees in the Neimer orchard were sprayed with lime-sulphur at scale strength, 1 to 7, on April 14. The leaves were out and the cluster buds had separated. A power sprayer was used and the pressure was run from 250 to 300 pounds. The trees were drenched with the strong liquid. The weather was clear and fair at the time the work was done.

Results.—In this orchard some severe injury was done to the buds and leaves. Decidedly more injury was done to the foliage than in any of the orchards treated in 1914 or in 1916. This injury

was due, no doubt, to the high pressure used in spraying, because other orchards were treated at practically the same time with the same strength of spray and no material injury was done. In other orchards where power outfits were used, the pressure was kept at about 200 pounds. Where barrel-pump sprayers were used, the maximum pressure was usually employed which ranged from about 70 to 90 pounds.

Some of the small leaves were entirely destroyed by burning and many of the buds were killed. Most of the trees set a heavy crop of fruit in spite of the injury. The spray injury could be seen much longer in this orchard than in any other orchard treated with the scale spray after the cluster buds had separated. About the first of July the fruit in this orchard was destroyed by the same hail storm that struck the Mason orchard, and no harvesting data were obtained.

EXPERIMENT STATION ORCHARD, 1916

Six trees in this plot were treated as follows:

Two were sprayed with lime-sulphur 1 to 8, April 15.

Two were sprayed with lime-sulphur 1 to 10, April 15.

Two were sprayed with lime-sulphur 1 to 12, April 25.

The lime-sulphur tested 33 degrees Baume. The trees were sprayed after the leaves were out and after the cluster buds had separated. A barrel-pump sprayer was used and an effort was made to spray the trees just as thoroly as if they had been infested with the San Jose scale. The work was done during clear weather.

Results.—No material injury was done to leaves or buds as a result of applying the strong spray. As usual, there was a slight burning of the edges and margins of the leaves. The surface of many of the leaves was slightly wrinkled. As much fruit set on the treated trees as on neighboring trees that were sprayed with the lime-sulphur and arsenate or lead at summer strength.

A little more injury was done where the solution was used 1 to 8 than where used 1 to 10 or 1 to 12. A careful examination also showed slightly more injury where the 1 to 10 solution was used than where the 1 to 12 was used. The casual observer would notice no difference. The main difference regarding the appearance of the treated trees as compared with check trees was not the burning or scorching of the leaves, but the light color on the trunk, limbs and branches due to the greater quantity of lime and sulphur in the concentrated scale spray.

The plant lice were controlled much better on the treated trees than on the check trees. Apple scab was controlled equally as well on the treated trees as on the checks.

WINFREY ORCHARD, 1916

This entire orchard was sprayed from April 16 to 24 inclusive, with commercial lime-sulphur 1 to 7. The strong solution tested 33 degrees Baume. The work was begun just before the cluster buds separated and was continued until the trees began to bloom. The owner of the orchard had neglected to spray for scale until it was apparently too late on account of the injury that might be done by spraying with lime-sulphur at San Jose scale strength. An adjoining orchard of 15 acres was sprayed with lime-sulphur at the same strength and at the same time. At least 75 acres of orchard was sprayed thoroly with this strong spray during the cluster-bud period in order to control the scale. Judging from former recommendations it was a dangerous experiment, but the owners of the orchards were willing to spray to kill San Jose scale even if the fruit buds were sacrificed in the spraying.

Results.—In the whole orchard of 75 acres, no material injury was done to leaves or buds. It is true that in many cases the edges and tips of the leaves showed burning, but no injurious results were noted at any time during the growing season. On the 60 acres of the Winfrey orchard, the fruit at harvest time was sold on the trees for \$4,500. From this it may be seen that the fruit and foliage were not materially injured.

The weather at the time of spraying was bright and clear and the clear weather continued several days after the work was finished.

The varieties in this orchard consisted mainly of Winesap, Jonathan, Ben Davis, Gano and York.

COMBINING CLUSTER-BUD AND SAN JOSE SCALE SPRAY, SPRING, 1917

Location of orchard	No. of trees	Age of trees	When sprayed	Material used	Outfit used	Variety
Station Orchard, Columbia	6	19 yrs.	Apr. 30	Lime-sulphur (1-7)	Barrel pump	Ingram

EXPERIMENT STATION ORCHARD, 1917

Six Ingram apple trees about 19 years old were used for this test. They were all sprayed just as they were coming into bloom, on April 30, 1917, with lime-sulphur testing 33 degrees Baume at a dilution of 1 to 7. The weather was cloudy and rainy, and it remained unsettled for several days.

Results.—No material injury was done to leaves or buds, as usual, the edges and margins of many of the smaller leaves were burned and browned considerably as a result of the application of the strong spray. Some of the leaves appeared to be wrinkled and drawn, due to the burning action of the lime-sulphur solution. The injury was not severe in any instance. No fruit buds were killed. The treated trees fruited equally as well and as heavily as the check or untreated trees. Apple scab was controlled as well or better than on the check trees.

COMBINING CLUSTER-BUD AND SAN JOSE SCALE
SPRAY, SPRING, 1918

Location of orchard	No. of trees	Age of trees	When sprayed	Material used	Outfit used	Variety
Station Orchard, Columbia	3	20 yrs.	Apr. 29	Lime-sulphur (1-7)	Power outfit	Ingram

EXPERIMENT STATION ORCHARD, 1918

Three of the Ingram apple trees which were used in the 1917 test were selected for the work in the spring of 1918. The application was made on April 29 with lime-sulphur testing 33 degrees Baume at a dilution of 1 to 7. The cluster buds had separated and a few of the buds had opened, showing the petals and the essential organs of the flowers. A power outfit was used in making the application. The trees were thoroly drenched with the spray. About seven gallons of the solution were used upon each tree. The pressure employed was 175 to 200 pounds.

Results.—The usual scorching or burning on the edges or margins of the leaves was observed. The surface of many of the leaves was wrinkled to some extent on account of the caustic action of the spray. No injury was done to the fruit buds and a heavy crop of fruit set.

The usual summer sprays were applied, and at harvest time, no one could observe any difference in the appearance of the fruit or foliage of the treated and untreated trees.



Fig. 3.—Ingram apple tree, Experiment Station Orchard, Columbia, Mo., as it appeared on April 29, 1918, when it was sprayed with commercial lime-sulphur testing 33° Baume at a dilution of 1 to 7

The three treated Ingram trees averaged $9\frac{1}{2}$ bushels of apples and the fruit was equally as good as that harvested from the untreated trees of the same variety. It is also interesting to note that one of these Ingram apple trees has been used for this experiment for three years, and one for four years. Both trees are equally as healthy and vigorous as any trees in the Experiment Station Orchard and they have produced a heavy crop of fruit each year.

ADDITIONAL INFORMATION

General methods for the control of the San Jose scale are discussed in Missouri Experiment Station Bulletin 132. For information on the care of orchards, address the College of Agriculture, Columbia, Mo.