New York Agricultural Experiment Station.

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Spraying for San Jose Scale.

H. E. Hodgkiss, F. A. Sirrine and E. L. Baker.

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BULLETIN NO. 273.

SPRAYING FOR THE SAN JOSE SCALE.

H. E. HODGKISS, F. A. SIRRINE AND E. L. BAKER.

SUMMARY.

This bulletin contains the results of the past year's experiments to determine the effects of a number of spray mixtures upon the San Jose scale and fruit trees. In this work various sulphur washes, the kerosene-lime mixture and soluble oil sprays have been used. Applications of these have been made at intervals during the early spring, summer and fall.

The fall applications of the sulphur washes gave, on the whole, satisfactory results. In several instances peaches and plums sustained more or less injury. The treatment upon San Jose scale was generally effective.

The kerosene-lime mixtures have proven rather unsatisfactory, for the applications often gave variable results upon the scale and the trees. Comparative tests with several grades of lime indicated that Limoid made the more stable emulsion. Analyses of several preparations of the kerosene-lime mixture showed that the larger percentage of the oil did not settle with the lime but rose to the surface in an emulsion with the lime. The variable results upon trees and scale were due to the imperfect distribution of this emulsified portion in the mixture.

Some tests were made with a soluble oil spray known as Scalecide. Although this gave some satisfactory results on scale, further experiments are necessary to determine its merits for the treatment of commercial orchards.
INTRODUCTION.

The experiments upon the use of various spraying mixtures for the treatment of orchards were continued during the past year. The object of the investigations was to determine the effect of these sprays on the San José scale and on fruit trees. Past experience has demonstrated conclusively that the scale may be controlled by thorough applications of any of the recognized remedies, but in the work that has been accomplished there were evidences of losses in the fruit yields which were largely attributable to injuries received in the treatment. For this reason it was important that the work be continued in order to determine especially the probable effects of such practice upon fruit production in average years. Various sulphur washes, the kerosene-lime mixture and soluble oil sprays were used in this work. The results attending the application of each of these washes are discussed separately.

FALL SPRAYING WITH SULPHUR WASHES.
H. E. HODGKISS AND F. A. SIRRINE.

Following the general plan outlined for former experiments, blocks of bearing apple, peach, and plum trees were selected in orchards situated in Ontario Co., near Geneva, and in Suffolk Co., near Northville. The conditions governing the treated trees were similar to those of last year with the exception of two orchards which received special treatment. Since differences in condition have an important bearing on the results, a brief description of each orchard is given:

**Orchard I.** *(T. C. Maxwell & Bros., Geneva.)*—The trees selected for treatment were seventy-three Reine Claude plums and twenty-five Fitzgerald peaches. The orchard has received very careful attention, and at the time of spraying was thrifty and entirely free from scale. Both varieties were about nine years old and had not been previously fall-sprayed.

**Orchard II.** *(H. H. Loomis, Geneva.)*—This is kept in clean cultivation but otherwise has received no care or previous treatment for insects. The trees are about twelve years old, and, with the exception of a slight infestation by the oyster-shell bark-louse, are thrifty and free from scale.

**Orchard III.** *(Thos. Maney, Geneva.)*—For the experiment, 129 Burbank and Reine Claude plums which had shown more or less scale injury during the previous year were selected. Both varieties are about seven years old and have received good care, particularly in the treatment of insects and plant diseases. This orchard was treated for scale in 1903.

**Orchard IV.** *(T. W. & J. P. Rice, Geneva.)*—A portion of this orchard comprising 102 Reine Claude and Burbank plums was used for a comparative test of the self-boiled lime-sulphur wash and various modifications of the kerosene-lime mixtures. The trees were about eight years old, vigorous, and with the exception of three trees were not seriously infested with the scale. No previous treatment for insect pests had been made in this orchard.
Orchard V. (Israel Luce, F. A. Sirrine, Northville.)—Peach and apple trees were used in this experiment. The peaches were selected with reference to vigorous growth and general neglect. The apples were young and healthy. Scale and leaf curl was present in the orchard during the previous year. The number of trees under experiment was 231, of standard varieties.

All orchards.—The total number of trees under treatment was 596; of these 41 were apples, 304 plums, 251 peaches. Checks were reserved in each orchard, which were representative of the sprayed trees.

CONDITIONS.

At Geneva the washes were applied between Nov. 11 and 22. The weather for this period was variable, generally cloudy with light winds. The temperature varied from 20° to 40° F. in the morning, and from 34° to 58° F. in the afternoon. There was no precipitation until Nov. 20, when a few snow flurries were followed by clear weather with a light snow at night.

During the treatment at Northville, made between Nov. 16 and Dec. 1, the weather was clear with brisk northeast to northwest winds.

The trees were sprayed once carefully and the following day any limbs not thoroughly coated received a second treatment. The weather conditions were much more favorable than in 1903, as severe cold did not set in until after the work was completed.

In each orchard, except Orchard IV, comparative tests were made with the several washes. In Orchard IV, the self-boiled lime-sulphur-caustic soda wash only was used in comparison with kerosene-lime-mixtures.

PREPARATION OF THE WASHES.

The washes were the same as those employed during the previous year, viz.: The lime-sulphur-salt wash prepared with and without external heat; the lime-sulphur wash; and the lime-sulphur-caustic soda wash, prepared with and without external heat. The formulæ and methods of preparation are as follows:
477

BOILED LIME-SULPHUR-SALT WASH.

Lime .............................................. 20 pounds.
Sulphur ........................................... 15 "
Salt .................................................. 15 "
Water ............................................... 50 gallons.

This was prepared in the usual method by first slaking the lime to a thin whitewash, and then adding the sulphur and the salt. These ingredients were distributed thoroughly in the whitewash and the mixture boiled from one to two hours.

SELF-BOILED LIME-SULPHUR-SALT WASH.

Lime .............................................. 40 pounds.
Sulphur ........................................... 20 "
Salt .................................................. 15 "
Water ............................................... 60 gallons.

This wash was cooked without the direct use of external heat. First, the sulphur was made into a paste with hot water and was then emptied into a barrel containing forty pounds of lime, which was started to slake with twelve gallons of boiling water. During the slaking process, the barrel was covered to prevent the loss of heat. Occasionally the wash was stirred to secure a more uniform distribution of the sulphur in the whitewash. In twenty minutes after the time that the lime first commenced to slake, enough boiling water was added to make the required sixty gallons of mixture; after which the salt was added and stirred until dissolved. The wash was then strained and applied hot.

LIME-SULPHUR WASH.

Lime .............................................. 20 pounds.
Sulphur ........................................... 15 "
Water ............................................... 50 gallons.

This mixture was made in the same manner as the boiled lime-sulphur-salt wash except that the salt was omitted.

SELF-BOILED LIME-SULPHUR-CAUSTIC SODA WASH.

Lime .............................................. 30 pounds.
Sulphur ........................................... 15 "
Caustic soda ..................................... 6 "
Water ............................................... 50 gallons.
In preparing this wash the lime was started to slake with six gallons of water; and, as soon as the slaking commenced the sulphur, which had just previously been made into a thin paste with hot water, was added and thoroughly mixed in with the slaking lime. To prolong the boiling of the wash, the caustic soda was then used, with water as needed, and the whole mixture was kept thoroughly stirred. As soon as the chemical action had ceased the required amount of water was added, when the mixture was ready for use. The soda used in the preparation of this wash is a powdered 74 per ct. caustic soda, sold by the Penn Chemical Works, 1322 Washington Avenue, Philadelphia, Pa. It sells for 4 cents a pound and is contained in 50 lb. cans.

**Boiled Lime-Sulphur-Caustic Soda Wash.**

<table>
<thead>
<tr>
<th>Component</th>
<th>Quantity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lime</td>
<td>30 pounds.</td>
</tr>
<tr>
<td>Sulphur</td>
<td>15 &quot;</td>
</tr>
<tr>
<td>Caustic soda</td>
<td>6 &quot;</td>
</tr>
<tr>
<td>Water</td>
<td>50 gallons.</td>
</tr>
</tbody>
</table>

This was prepared in the same manner as the self-boiled lime-sulphur-caustic soda wash, after which the mixture was boiled for one or two hours over a fire.

**RESULTS.**

*Orchard I: Peaches.*—In the early spring with the opening of the buds the blossoms and leaves appeared normal and no difference could be seen between the check and treated trees. Subsequent examinations, made on May 22, June 14 and July 24, showed no apparent variation. On August 15 the foliage of the treated trees appeared better than that of the unsprayed trees. With respect to the fruit yields there was no difference. In every case the fruit was small and of poor quality.

*Plums.*—Buds on the check trees opened May 9, while those on the sprayed plums were retarded for nearly a week. At this time the untreated trees had uniformly more foliage, but observations made on May 12, 22, June 14 and July 24 showed very little difference in this respect. On Aug. 15 the checks had begun to drop the foliage owing to the attacks of the shot-hole fungus (*Cylindrosporium padi* Karst.) but this defoliation did not
affect the fruit yield, which was very satisfactory in quantity and quality.

Orchard II: Apples.—A variation in the action of the washes was noticeable when the blossoms appeared which was apparent on some trees in all the rows receiving treatment. With the advancement of summer there was a more abundant growth on the sprayed trees, which appeared to be more vigorous than the checks.

Orchard III: Plums.—In the early spring the trees treated with the self-boiled lime-sulphur-salt wash showed more injury than the trees sprayed with the other washes. On some of the trees there was a destruction of nearly one-half of the leaf-buds. The remainder of the plums showed fewer leaves on the lower and inner spurs than the checks. However, the increased growth of the new wood caused a great improvement in the appearance of the sprayed trees which subsequently fully equalled the checks in quantity of foliage and fruit yields. The previous yield of plums was practically worthless from scale injury, but this year a clean crop was marketed.

Orchard IV: Plums.—The self-boiled caustic soda wash caused severe injury to a tree which was evidently weakened by scale in the previous year. Otherwise the condition of the sprayed trees was satisfactory and remained so throughout the summer.

It is well to mention that applications of the kerosene-lime washes in this orchard gave varying results and in some instances caused very severe injuries. A number of trees were killed and the remainder were so injured that they produced only about one-quarter of a crop of fruit. The trees treated with the sulphur wash yielded a full crop of fruit and on Aug. 15 were in much better condition than those treated with other sprays.

Orchard V: Peaches.—Early in the spring a comparison of sprayed and unsprayed peaches showed no apparent differences with respect to fruit and leaf buds. The varieties treated with the self-boiled caustic soda wash were the more exposed to the severe winds and on March 27 Mr. Sirrine reported a considerable shriveling of the young wood. Checks under similar exposure were less severely injured, while the trees receiving an application of the boiled sulphur wash were somewhat less exposed
and consequently the injuries from this source were not as conspicuous. An examination on May 6 showed that 75 per ct. of the spurs on all the trees were killed, and it was evident from the condition of the checks that less than 10 per ct. of the injury on the treated trees was due to the spraying.

Effect on curl.—Peach leaf curl was present on both sprayed and unsprayed trees. The sprayed section had 1.5 per ct. of curled leaves as compared with 85 per ct. of curl on the checks.

Apples.—Applications of the self-boiled caustic soda wash had no injurious effect on the trees. This treatment practically eradicated the scale, only a few being found on fruit taken from isolated branches which apparently had not been covered by the spray. The apples on the checks were worthless from scale infestation.

SUMMARY.

The results from spraying in the autumn of 1904 have been quite satisfactory. In Orchard I there has not been at any time during the summer any evidence that the treatment was other than beneficial. A similar effect was seen in Orchard II. One section of Orchard III was somewhat severely injured by the application of the self-boiled lime-sulphur-salt wash, but this difference was overcome during the summer by the increased growth of the trees. The results from Orchard IV showed that the kerosene-lime mixtures were unstable and in many cases were unsafe washes; for the application often caused marked reductions in leaf and fruit buds, and in some cases the death of the trees. The lime-sulphur-caustic soda wash used in this experiment caused serious injury to one tree very badly infested with scale but otherwise the spray gave satisfactory results. The peaches in Orchard V were badly winter-killed, but it is believed that about 10 per ct. of the buds were injured by the treatment. Apples in this same orchard were uninjured by the sprays, and the scale was satisfactorily controlled.

GENERAL SUMMARY AND CONCLUSIONS.

In the previous work upon this problem the results attending the application of the sulphur washes were somewhat conflicting, since some of the treatments caused serious injuries to the buds
and blossoms, while others in no manner affected the health of the trees. But as regards the insecticidal value of the treatments all the experiments showed that applications at this season were uniformly effective upon scale. The work indicated that the injuries sustained by the trees were balanced by their increased vigor and fruitfulness due to the control of the scale. The probable losses that an orchard would sustain were not indicated by this single experiment. These, in order to be thoroughly understood, called for further observations covering a number of years.

The conditions governing the past year's experiment were more favorable for making the test. The wood was well ripened and the weather in the fall leading up to the spraying season was mild, while the winter was less destructive to fruit trees, especially those that were injured by insects and fungi. The applications of sulphur washes were, on the whole, not detrimental to the trees and kept the scale well in control.

From these results it is not safe to conclude that spraying in the fall is unattended with danger, as the resistance of a tree is largely determined by its health upon entering the winter. Likewise the kind of spray employed and the hardiness of the variety are important factors.

Whether or not it is advisable to spray in the fall seems to be a matter of expediency. A profitable orchard infested with scale will soon cease to be remunerative if neglected, and spraying, if it cannot be done in the spring, should be done in the fall; as the losses likely to follow will be more than compensated by the increased vigor of the trees and value of the fruit produced.
THE KEROSENE-LIME MIXTURE.

H. E. HODGKISS AND F. A. SIRRINE.

This is one of the comparatively new sprays that has been introduced for the control of the San José scale and has attracted considerable attention through the efforts of the Delaware Agricultural Experiment Station.\(^2\) The kerosene-lime mixture is a mechanical emulsion of lime, kerosene and water, the lime acting as a carrier for the oil, while the water serves largely as the diluent. Kerosene is one of the most penetrating and destructive of insecticides, but when applied pure may cause severe injuries. In the employment of lime it has been thought that a combination has been secured by which the oil could be more safely used. In these experiments tests have been made with Limoid and various grade and superfine limes from Ohio and New York.

CONDITIONS.

As has been done in other experiments, blocks of bearing apple, peach, and plum trees were selected for treatment. With the exception of a few badly scale-encrusted trees the orchards in which the experiment was made were in a vigorous condition. The sprays were continued at irregular intervals during the spring and summer.

THE MIXTURES AND THEIR PREPARATION.

The mixtures were prepared in several percentages as follows:

<table>
<thead>
<tr>
<th>Percentage</th>
<th>Kerosene</th>
<th>Lime</th>
<th>Water</th>
</tr>
</thead>
<tbody>
<tr>
<td>10%</td>
<td>5 gal.</td>
<td>20 lbs.</td>
<td></td>
</tr>
<tr>
<td>12.5%</td>
<td>6 gal.</td>
<td>30 lbs.</td>
<td></td>
</tr>
<tr>
<td>15%</td>
<td>7.5 gal.</td>
<td>40 lbs.</td>
<td></td>
</tr>
<tr>
<td>20%</td>
<td>10 gal.</td>
<td>50 lbs.</td>
<td></td>
</tr>
<tr>
<td>25%</td>
<td>12.5 gal.</td>
<td>60 lbs.</td>
<td></td>
</tr>
<tr>
<td>30%</td>
<td>15 gal.</td>
<td>70 lbs.</td>
<td></td>
</tr>
<tr>
<td>35%</td>
<td>17.5 gal.</td>
<td>80 lbs.</td>
<td></td>
</tr>
<tr>
<td>40%</td>
<td>20 gal.</td>
<td>90 lbs.</td>
<td></td>
</tr>
</tbody>
</table>

The kerosene and lime were thoroughly mixed together into a thin "'sloppy'" mass and the required amount of water was added;

PLATE I.—SULPHUR WASHES: EFFECT OF FALL SPRAYING ON PLUMS.
UPPER, REINE CLAUDE; LOWER, BURBANK.
after which the whole mixture was stirred vigorously in order that the entire "sloppy" mass should be thrown into suspension. It was then pumped back into itself with the spray pump for from three to five minutes to insure a thorough emulsification of the ingredients.

THE ORCHARDS.

The orchards in which the treatments were made are located in Ontario Co., at Geneva; in Suffolk Co., at Northville; and in Niagara Co., at Youngstown. The conditions were the same as those given in the previous section for Orchards II, IV and V. In addition an orchard was selected for the summer spraying in which the trees were about forty years old and very badly scale infested. At Youngstown a portion of an apple orchard of 400 trees which was infested with scale received the spring treatment with this mixture in comparison with the recognized standard sprays.

The total number of trees under experiment was 673, of standard varieties of apples, peaches and plums.

DISCUSSION OF EXPERIMENTS.

FALL TREATMENT.

Orchard IV: Plums.—In this orchard 63 Burbank and Reine Claude plums, and two small cherries were sprayed. These trees in the past had been very productive and were thrifty. Local hydrated lime was used and applications containing 10 per ct., 15 per ct., 20 per ct., 25 per ct., 30 per ct., 35 per ct. and 40 per ct. of oil were made. The preparations having the higher percentages of oil were applied with difficulty as the washes were very heavy because of the small quantity of water used in proportion to the amount of lime employed. For purposes of comparison some trees were treated with a 10 per ct. limoid-kerosene wash.

Results: Hydrated lime mixture, 10 per ct. oil.—This mixture was applied to 13 Reine Claude plums, each tree being numbered with respect to the order in which it was sprayed. On May 10 trees 1 and 2 were severely injured, the only evidence of life being scattering blossoms and leaves on the tips of the high-
est branches. With the coming of summer these trees gradually weakened and on July 20 were dead. Early in the season trees 3–13 inclusive showed no injury, the leaves and blossoms being abundant and well distributed. Only a small percentage of the blossoms set fruit and the crop was small.

**Limoid mixture, 10 per ct. oil.**—This was sprayed on 9 Reine Claude plums. Trees 1 and 2 were dead on May 10, and tree 3 had no living spurs on the inner branches although the upper portions were well covered with foliage and blossoms. At this time trees 4–9 inclusive had on one side abundant foliage and blossoms, while the other half was devoid of blossoms, but had a heavy leafage. On July 20 trees 1 and 2 were dead while the remainder of the trees were sickly and bore a small yield of fruit.

**Hydrated lime mixture, 15 per ct. oil.**—Nine Reine Claude plums were sprayed and numbered as with the other treatments. Tree 1 was nearly dead when examined May 10; and tree 2 had a large number of blossoms in the upper portion, while the lower limbs had neither blossoms nor leaves. The third tree was heavily covered with blossoms and leaves on one side while on the opposite side the buds were only partially opened. The remainder of the trees had abundant foliage but few blossoms. On July 21, trees 1 and 2 were dead, tree 3 had one-half of the normal leafage and no fruits. Trees 4–9 inclusive had a large number of leaves and a very small crop of fruit.

**Hydrated lime mixture, 20 per ct. oil.**—This wash was applied to 9 Reine Claude plums and one small cherry. An examination early in the spring showed that about one-quarter of the buds were killed while the remainder were greatly retarded. With the advance of spring the blossoms were scattered thinly over the trees. Only a few of these set fruits so that the yield was very small.

**Hydrated lime mixture, 25 per ct. oil.**—Nine Reine Claude plums were sprayed and all showed injury on May 10. Tree 1 was dead, trees 2–7 had only scattering leaves and blossoms, and the remaining trees were uninjured. The latter bore an average crop of fruit, while the former had none.

**Hydrated lime mixture, 30 per ct. oil.**—Applications were made to one Reine Claude plum, five Burbank plums and one small
cherry tree. On May 10 tree 1 was about dead, tree 2 was in a similar condition, and the other trees were without blossoms but had a heavy foliage. On July 21, 4 trees were dead, one severely injured, and the remaining trees were slowly dying. Later in the summer all the trees receiving the treatment were dead.

*Hydrated lime mixture, 35 per ct. oil.*—Applications of this were made to four trees. On May 10, tree 1 was dead and the foliage on trees 2 and 3 was sparse. Tree 4 had a good crop of leaves and blossoms, but matured about one-third of a crop of fruit.

*Hydrated lime mixture, 40 per ct. oil.*—Four Burbank plums were sprayed and at the first examination on May 10 showed considerable reduction in blossoms and leaves on the inside spurs, although the outer branches were well covered. These trees had about one-fifth of a crop of fruit.

In comparison with the above it is interesting to note the results on trees of the same variety in adjacent rows, which while they had been sprayed with the sulphur wash served as checks. These trees blossomed heavily and produced full yields.

*Orchard V: Peaches.*—A block of fifteen young thrifty peaches in a well cultivated orchard and another comprising 58 trees in a neglected condition were sprayed with the 10 per ct., 20 per ct. and 40 per ct. mixtures on Dec. 5. Scales were abundant on the neglected trees at the date of applying the washes.

*Results: Limoid mixture, 10 per ct., 20 per ct., 40 per ct. oil.*—In the spring the younger growth on all the trees receiving the applications showed somewhat more extensive injuries from winter-killing than the checks. On Oct. 23 of the following autumn Mr. Sirrine reported that the trees which received applications of the 10 per ct. and 20 per ct. oil were in no better condition with respect to the number of living scales than the checks, but that the bark was somewhat smoother owing to the removal of the old scales by the weathering off of the whitewash. The trees receiving the highest percentage of oil, while they showed some improvement over the checks, were well covered with young scales.

*Effect on peach leaf curl.*—In the spring following the treatment, the sprayed trees apparently had as much leaf curl as the
checks. A count of the leaves on the sprayed trees showed an
average of 76 per ct. of curled leaves, which was about the
amount of the infestation of the checks.

**SPRING TREATMENT.**

*Orchard IV: Plums.*—Just before the buds opened a block of
plums equal in number and similar in variety to those selected
for treatment during the previous fall received an application of
the 10 per ct. and 25 per ct. mixtures containing hydrated lime.
The trees were slightly infested with scale.

*Results.*—When the buds opened these trees had more foliage
and blossoms than the fall-sprayed portion, but a greater variabil-
ity in the condition of the different varieties was quite notice-
able. Burbank plums which had abundant foliage and blossoms
soon turned brown and in a few weeks were dead. Other trees
of the same variety had no blossoms but heavy foliage, and
remained healthy throughout the summer. Reine Claude plums
and cherries showed a greater variation. All the trees blossomed,
some very slightly, but the amount of fruit in each case was not
large. Small fruits, such as currants and raspberries, planted
between the trees were either killed or so badly injured by the
spray that they produced no fruit.

*Orchard V: Apples.*—In this orchard five large apple trees
which were in a neglected condition as regards scale were treated
with the 20 per ct. and 40 per ct. mixtures.

*Results: Limoid mixture, 20 per ct., 40 per ct. oil.*—During the
summer following, the treated trees were not in as healthy con-
dition as the checks, as the foliage was less abundant and off
color. At the last examination the trees receiving the applica-
tion of the 20 per ct. oil were as badly scale-infested as the checks.
The 40 per ct. oil was more effective on the scale and in addition
seemed to aid in clearing the bark of lichens and moss.

*Orchard VI: Peaches.* At Laurel, in Suffolk Co., 45 scale-
incrusted peaches were sprayed with the 10 per ct., 20 per ct.
and 40 per ct. mixtures.

*Results: Limoid mixture, 10 per ct., 20 per ct., 40 per ct. oil.*—
The weaker percentages did not appreciably lessen the number of
mature female scales, while the 40 per ct. mixture proved to be:
somewhat more destructive. On Oct. 23 larvae and mature scales were abundant on sprayed and unsprayed trees.

*Effect on curl.*—Peach leaf curl was very abundant on the treated as well as on the untreated trees.

*Orchard VII: Apples.*—In a well cultivated orchard near Geneva, 130 trees were sprayed with either the kerosene-lime mixture or with one of the sulphur washes to determine their comparative merits for the control of the scale which was quite abundant in the orchard. The 25 per ct. oil mixture was used on twenty-four trees, and after the falling of the blossoms twelve of these were given the second and third treatments with the bordeaux-arsenical mixture. The remainder of the orchard was sprayed with several sulphur washes during the dormant season and after the falling of the blossoms the usual applications of the bordeaux mixture, containing an arsenical poison, were made to a number of these trees.

*Results.*—With the opening of the buds no apparent injuries were noticeable on any of the trees. On Oct. 12 the apples were picked. The yields from the trees treated with the kerosene-lime wash showed an average infestation by the scale of 98.2 per ct. while the fruit from the trees sprayed with the lime-sulphur wash had an average infestation of 9.8 per ct. The checks were completely infested. The fruit from the section treated with the oil spray, without the bordeaux-arsenical mixture, were 19.8 per ct. scabby as compared with 1.3 per ct. of scabby apples taken from the trees receiving treatment with the oil and the bordeaux mixture. The fruit from the trees sprayed with sulphur wash only, were 4.7 per ct. scabby, while those from the trees receiving applications of the sulphur wash and the bordeaux mixture had an average of 3.2 per ct. of scab. The checks had 28.5 per ct. of scabby fruit.

Trees treated with the oil spray only, had 21.1 per ct. of the fruit injured by larvae of the codling moth, while those sprayed with the bordeaux arsenical mixture in addition showed two per ct. injury by this insect. The fruit from the trees treated with sulphur wash only was 56.6 per ct. wormy as compared with an average of 17.7 per ct. wormy fruit from the trees receiving one application of the sulphur wash, supplemented by the second and
third treatments with the bordeaux mixture. The checks had 30.7 per ct. of wormy fruit.

**Orchard VIII: Apples.**—In Youngstown, Niagara County, a portion of a thrifty bearing orchard of 400 trees received applications of the 25 per ct. kerosene-lime mixture. At the time of spraying scale was abundant on the trees.

**Results: Hydrated lime, 25 per ct. oil.**—Of 69 trees receiving applications of this wash 15 showed on May 20 severe injuries to one side while the other portion had an abundance of leaves and blossoms. Trees in this orchard which received applications of the sulphur washes were in a very satisfactory condition. The effects of the kerosene-lime mixture on scale, as would be determined by the extent of the spotting of the the fruit, was not satisfactorily shown owing to an unusually small crop of apples which was generally clean through the entire orchard.

**SUMMER TREATMENT.**

**Orchard IX: Apples.**—For this experiment an orchard was selected in Geneva which was very badly infested with the scale. The trees under observation were twelve Baldwins and Greenings divided equally as regards variety and about 40 years old.

In connection with the treatment for scale an experiment was conducted to determine the comparative merits of various grades of lime in the preparation and use of the kerosene-lime mixtures.

**CONDITIONS.**

In the experiment the 10 per ct. oil mixture was used, being prepared with the grade and superfine Limoid, and the grade and superfine Marblehead lime. The mixtures were made in 50-gallon lots and each lot was applied separately. In order to ascertain its condition after preparation and while being sprayed, samples were taken of each lot after emulsification and at equal intervals at the discharge from the nozzle.

The wash was applied on June 11, at which time the foliage was heavy and the fruit of a good size. The weather during the day was hot with showers at intervals. The results are as follows:
THE MIXTURES.

Limoid, superfine.—Three 50-gallon lots were prepared by the common method. This lime formed a smooth paste with the oil, and after the addition of water and agitation by the pump a complete emulsion was apparently made. Fifteen samples taken in 1,000 c.c. cylinders from the three different lots showed the following results with respect to the relative proportions of lime-oil emulsion, free oil, water and lime in each container. Attention is directed to the interesting fact that whitewash without the lime and oil emulsion was being sprayed on the trees at intervals during the application of lots 2 and 3 while in the application of lot 1 nearly one-half of the mixture was lime-oil emulsion.

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</table>

Limoid, grade.—Five 50-gallon lots were prepared by the common method. This lime formed a creamy mass with the oil, which, upon the addition of the water followed with agitation by the pump, gave a mixture with no free oil. The oil was apparently completely emulsified. The emulsion, however, was not evenly distributed in the mixture, as the table shows.
**TABLE II. QUANTITY OF EMULSION, FREE OIL, WATER, AND LIME IN THE GRADE LIMOID MIXTURE TAKEN IN 1000 C.C. CYLINDERS.**

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_Marblehead lime, superfine._—Five 50-gallon lots were prepared by the common method. This lime formed an uneven lumpy paste when mixed with the oil and did not retain oil satisfactorily after agitation was applied. Repeated attempts to make a good mixture resulted in failure. In the following table may be seen the variation in the various mixtures as shown by 25 samples taken from the five different lots:
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<th>Lot</th>
<th>Sample</th>
<th>Emulsion</th>
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Marblehead lime, grade.—This lime was prepared in four 50-gallon lots. The lime formed a white pasty mass which did not retain the oil on the addition of water followed with agitation. The force of the pump appeared to drive the oil from the lime. As with the preceding lime the attempts to produce a complete emulsion resulted in failure. A comparison of 16 samples taken from the four lots will show the extreme variation of the mixture made with this lime.
Table IV. Quantity of Emulsion, Free Oil, Water, and Lime in the Grade Marblehead Lime Taken in 1000 c.c. Cylinders.

<table>
<thead>
<tr>
<th>Lot.</th>
<th>Sample No.</th>
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<th>Water (C.c.)</th>
<th>Lime (precipitate)</th>
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Effect on trees.—The grade and the superfine limoid and the superfine Marblehead mixtures caused some spotting and burning of the leaves and fruit which was accompanied with serious dropping of the leaves. Some of the trees had the foliage badly burned, while others treated by the same preparation showed no such injury. The grade Marblehead lime mixture caused more serious injury to the foliage and branches than any of the other washes. The injuries to the fruit, leaves, and young growth appeared very soon after the treatment.

Effect on scale.—None of the washes appeared to be constantly effective in destroying the scale. While some applications gave satisfactory results in this respect, many treated trees were at the end of the season as badly infested as the checks. There was no practical difference in the effectiveness of the several mixtures. The irregularities seem largely attributable to the instability of the emulsion and its uneven distribution in the wash.
SUMMARY AND CONCLUSIONS.

The experiments with the kerosene-lime mixture during the past year show that the applications of this wash have given variable results upon trees and scale. The lower percentages of oil were generally ineffective on scale but the mixtures containing higher percentages of oil were more efficient. The comparative test with various limes showed that the best results were obtained by the use of Limoid.

The percentages of kerosene in well prepared mixtures were determined by Mr. Baker, as given in detail in the next section. These determinations indicated that the larger percentage of oil is formed into an emulsion with a portion of the lime which remains in suspension, while the remainder of the oil, which is small in quantity, is carried to the bottom by the lime which settles. Probably the chief reason for the variable results upon scale attending the application is the imperfect distribution of the emulsified lime-oil portion in the mixture.

While the use of the kerosene-lime wash in this work has on the whole proven unsatisfactory, it is intended to continue the experiments next season to determine if a safe and efficient combination of the oil and lime can be made.
DETERMINATION OF KEROSENE IN THE KEROSENE-LIME MIXTURE.

E. L. BAKER.

When lime, kerosene and water are mixed in certain proportions, it has been shown that an emulsion is formed, and that the whole mixture, after agitation ceases, separates into three layers. Because of this separation there may be unequal distribution of the ingredients of the mixture in spraying, and for this reason it was thought a matter of interest to determine both the quantity of kerosene present in each of these layers, and the relative proportion of kerosene held in emulsion when different limes are used.

Four different mixtures were examined. These were prepared according to the 10 per cent. formula previously given, using the following limes: (I) Superfine Marblehead lime, (II) grade Limoid, (III) superfine Limoid, (IV) grade Marblehead lime.

After thorough agitation, a one-gallon sample was immediately taken from each of the mixtures and put into large glass jars. The contents of these jars were thoroughly stirred and then poured into separatory funnels. In ten to fifteen minutes three distinct layers formed. These were separated by drawing off each successively into flasks which were then tightly corked to prevent evaporation.

METHOD OF DETERMINATION.

A quantity of the lime-kerosene mixture is weighed into a flask, which is connected to a condenser, and steam is passed into it. The kerosene all distils over and forms a separate layer above the water which passes over with it. The distillate is allowed to drop into a burette, from which the lower layer of water is drawn away from time to time. After the distillation is complete, the amount of kerosene may be read in cubic centimeters. This reading multiplied by the specific gravity of the kerosene, which has been previously taken, gives the weight. Knowing the weight of the mixture taken, the percentage of kerosene can easily be calculated.
Plate III—Duplicate Samples of Kerosene-Tar Mixtures Showing Variation: 1, Superior Marbleshed Line; 2, Superior Limoid; 3, Grade Limoid; 4, Grade Marbleshed Line.
Plate No. IV gives a view of the apparatus and shows the layer of kerosene in the burette.

PRELIMINARY DISTILLATIONS.

In order to show that this method was quantitative for kerosene, two trial distillations are made. First, 5 c. c. of kerosene was measured into a 500 c. c. flask by means of a pipette and distilled with steam for about two hours; at the end of which time it was found that the entire 5 c. c. had passed over. A duplicate distillation was made giving precisely the same result.

Next a small mixture of lime, kerosene and water was made up as follows:

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<th>Lime</th>
</tr>
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</tbody>
</table>

Kerosene......................... 10 c. c.
Water............................. 88.9 c. c.
Lime............................... 4.5 grams.

This mixture is in the same relative proportion as the 10 per cent. kerosene-lime mixture. In this case, as in the previous experiment, all of the kerosene passed over.

These trial distillations show that by this method the entire amount of kerosene is obtained.

DISTILLATION OF LAYERS.

Twenty-five to thirty grams of each of the lower layers were weighed out in duplicate and distilled according to the method described above. Practically all of the kerosene, about 1 c. c. in each case, passed over in one hour, but the distillation was continued for an hour longer to get the last traces of the oil.

Fifteen to twenty grams of the upper layers were weighed out and distilled in the same way. The time of distillation, however, was much longer, from six to eight hours, and 10 to 15 c. c. of kerosene passed over.

Similar distillations of the middle layers were made, but no kerosene was found.

The condition of all the layers with regard to the kerosene content is given below in the tabulated restults:
From the above results it will be seen that by far the greater part of the kerosene is found in the upper layer, while only a small portion of the oil is carried to the lower by the lime as it settles down.

The percentage of kerosene in the top layers varies somewhat with the different limes used. This difference is not so noticeable in the lower layers.
SCALECIDE.

H. E. HODGKISS.

The soluble oil preparations are comparatively new sprays which during the past year have been widely advertised for the treatment of the San Jose scale. There are now several brands on the market, to each of which a proprietary name has been given. As opportunity has permitted, rather extensive tests have been made with these preparations to determine their merits as compared with standard remedies. As the work with it has been longer continued, the following notes on the results with Scalecide, one of the first of the brands to be introduced, are given to indicate the probable value of the miscible oils for orchard treatment. Applications of Scalecide were made during the dormant season and were continued at irregular intervals throughout the summer and fall. The work being in progress at the present time, the results from the fall treatment cannot be obtained.

CONDITIONS OF TESTING.

On April 26 when the buds were swelling, a block of 20 apples, 5 pears, 1 peach and 1 quince was sprayed with various percentages of the oil. Apples and peaches were badly scale-infested while the other kinds of fruit had only a few traces of scale.

PREPARATION OF THE MIXTURES.

Percentage of oil, 3 per ct.: Scalecide, \( \frac{3}{4} \) gal.; water, 25 gals.

<table>
<thead>
<tr>
<th>Oil Percentage</th>
<th>Water (gal.)</th>
<th>Scalecide (gal.)</th>
<th>Total (gal.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>5</td>
<td>1</td>
<td>20</td>
<td>26</td>
</tr>
<tr>
<td>7 1/2</td>
<td>1 1/2</td>
<td>20</td>
<td>23 1/2</td>
</tr>
<tr>
<td>10</td>
<td>2</td>
<td>20</td>
<td>22</td>
</tr>
<tr>
<td>15</td>
<td>3</td>
<td>20</td>
<td>22</td>
</tr>
</tbody>
</table>

The oil and water were stirred vigorously, after which the mixture was pumped back into itself until the Scalecide which first appeared on the surface was completely mixed with the water.
DISCUSSION OF TREATMENTS AND RESULTS.

EARLY SPRING APPLICATION.

Five per ct. Scalecide: Apples.—On April 26, seven trees were sprayed with the five per ct. wash. The buds at this time were slightly swollen. The weather for the week following the application was clear, with slightly increasing temperature. The buds on the check trees opened rapidly during the first week of May but the treated trees were not as far advanced. On May 15, 45 per ct. of the buds on the sprayed trees were not open while the checks were in full foliage. During the following two weeks the former were greatly improved in appearance, and by Aug. 15 the foliage on them seemed to be more abundant than that on the unsprayed trees.

Plums.—Three plum trees sprayed on April 26 were examined on May 15. There was no difference at this time between the checks and treated trees and these conditions continued the same throughout the summer.

Pears.—Three pear trees treated before the buds opened showed severe retardation during the early part of May. A careful examination at that time showed that about 75 per ct. of them were well open. Four weeks later these buds had fully developed, and the only trace of injury was the relatively less abundance of the leaves on the inner and lower spurs.

Ten per ct. Scalecide: Apples.—For this application seven badly infested apple trees were selected. These were sprayed April 26. On May 10 about 15 per ct. of the buds had opened while others were somewhat retarded. As the season developed the effect of the oil became less noticeable, and by the first of June the foliage was heavy and of a good color.

Peach.—A five year old peach tree, much infested, was selected for treatment. In making this treatment only one-half of the tree was sprayed while the remaining half was left as a check. As the buds opened no difference could be detected between sprayed and unsprayed portions except that there was a slight retardation by the treatment.

Two weeks later the entire tree was in full foliage and no difference could be seen between the two portions. On Aug. 1 the leaves on the checks were beginning to drop and by September
this portion was completely defoliated, while the sprayed portion retained its foliage until the appearance of frosts.

**Pears.**—Observations on May 16 showed that pear trees receiving this treatment had about 54 per ct. of the buds retarded. As the season advanced these buds opened and the foliage ultimately equalled that of the checks.

**Fifteen per ct. Scalecide: Apples.**—Seven trees were treated just before the buds commenced to swell. An examination on May 15 showed that about 75 to 100 per ct. of the buds were retarded. With the advancing spring this difference became less apparent and in the late summer the foliage was much better than that of the checks.

**Pears.**—An application of this percentage to four trees gave results similar to those obtained with the apples described above. The trees however, made a vigorous growth during the summer.

**SUMMER APPLICATIONS.**

Beginning June 20, a series of applications was made to apples, pears, peaches and plums using the 3 per ct., 5 per ct. and 7½ per ct. solutions. During the few days following each spraying the weather conditions were very favorable.

**Results: On peaches, 3 per ct., 5 per ct. and 7½ per ct. Scalecide.**—The foliage on the trees receiving applications of the 3 per ct. Scalecide showed severe burning. The general appearance of the leaves was as if punctured by hail stones. The fruit which had become sizable was uninjured.

The five per ct. solution affected the foliage in a manner somewhat similar to that described above. The fruit however was badly burned and did not develop.

Applications of the 7½ per ct. Scalecide entirely defoliated the trees.

**On apples, with 3 per ct., 5 per ct. and 7½ per ct. Scalecide.**—The apple leaves on the trees receiving the several treatments were severely burned and the fruit marked with black corky spots. The injured fruits grew to a good size but were imperfect. The injury by the different sprays was equally severe.

**On pears, with 3 per ct., 5 per ct. and 7½ per ct. Scalecide.**—Pears were injured in much the same manner as the apples. The injury to the fruit however became less prominent as the
season advanced. All the treatments caused an equally severe injury.

On plums with 3 per ct., 5 per ct. and 7½ per ct. Scalecide.—The applications of the 5 per ct. and 7½ per ct. strengths seemed safe. But later in the summer further experiments were made to determine if the oils were uniformly safe to plum foliage. In this work the results were quite different, for the fruit was badly spotted and the leaves burned, which resulted in severe defoliation.

EFFECT ON SCALE.

The trees receiving treatment during the dormant season appeared to be entirely free from living scale when examined during June, July, and the first week in August. During the last week in August young living scales were detected upon the trees receiving applications of 5 per ct. and 10 per ct. oil. No living scales were seen on the trees sprayed with the 15 per ct. oil at any time during the summer. The applications containing 3 per ct. Scalecide seems to have little or no effect upon the scale.

SUMMARY.

A careful examination of the results obtained by the use of this oil showed that spraying during the dormant season was accompanied with a great retardation of the buds. But later these opened so that ultimately there was little difference in this respect between the sprayed and unsprayed trees. The results in this particular attending applications of 5 and 10 per ct. Scalecide were not important, but the retardation following the treatment with the 15 per ct. oil was very severe. In many cases the treatment seemed to promote the growth of better foliage. Summer spraying with Scalecide in every instance caused severe injuries. In these experiments, 3 per ct. Scalecide had no appreciable effect on the scale. Applications containing 5 per ct. and 10 per ct. oil seemed to destroy from 80 to 95 per ct. of the scale. The higher percentage seemed to entirely control the scale.

While the Scalecide at first gave promising results, it seems best in view of the variable results upon scales and trees in all instances in the later work to continue these tests to determine its merits as an orchard spray.