SULPHUR SPRAYS FOR ORCHARD TREES. II.

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To many work-burdened orchardists of New York, the coming of San José scale seemed the proverbial "last straw." The remedies in common use had little or no effect upon the scale, yet neglect to care for infested trees meant their early death. The burden of spraying for biting insects and fungous diseases was already great, the time and labor required for additional treatments were difficult to secure, and the expense cut deeply into the small profits that accompany low prices. Could scale treatment be combined with the treatments for leaf eaters and for diseases, as these had been combined with each other, the prospect would have been brighter; but fumigation or spraying with kerosene, petroleum, or whale-oil soap, and treatment with arsenicals or bordeaux mixture could not be advantageously united. Nor were the safer and more efficient sulphur washes any more capable of successful union with arsenic or copper sulphate. One ray of hope remained. Kerosene, petroleum, whale-oil soap and hydrocyanic-acid gas are without practical value as fungicides or as destroyers of biting insects; but the sulphur compounds were soon found to be

*This is a brief review of Bulletin No. 262 of this Station, on Sulphur Washes for Orchard Treatment, by P. J. Parrott, S. A. Beach and F. A. Sirrine. Any one specially interested in the detailed account of the investigations will be furnished, on application, with a copy of the complete bulletin. The names of those who so request will be placed on the Station mailing list to receive future bulletins, popular or complete as desired. Bulletins are issued at irregular intervals, as investigations are completed, not monthly.
more than merely scale-destroyers. As hinted in Bulletin No. 228 of this Station and as proved, to some extent, in Bulletin No. 247, these washes are quite efficient fungicides, so far as certain diseases are concerned; and also free the sprayed trees from many forms of insect life beside the scales.

Recent tests confirm these statements and make it possible to say that the thorough spraying of scale-infested trees, during their dormant season, with a sulphur wash, may take the place of the first one of the combined treatments with bordeaux and arsenicals for scale and scab. In this way the scale treatment requires but small additional expense and provides an effective treatment for many other pests at a time when the work can be done without interfering seriously with other duties.

In the tests which support these conclusions more than 7000 trees were treated, in sixteen orchards in widely separated localities. The plan of the tests was the same as in the work of 1903, with slight modifications and additions. Each orchard was divided into four sections in which different varieties of trees and trees of different ages or in different condition were grouped as evenly as possible, so that fair comparison might be made. The trees in Section I were sprayed once in early spring, before the buds opened, with a sulphur wash; those in Section II received one treatment with the sulphur wash followed by two applications, after the blossoms fell, of bordeaux and poison; Section III was the check, trees not sprayed; and in Section IV the trees were given three sprayings with the bordeaux-arsenical combination, one before the buds opened, two after the blossoms fell.

Apples, pears, peaches, plums, prunes and cherries were included in the tests.

In use of the sulphur washes the same defects were observed as in other years and with other spray treatments. It is found almost impossible, when working upon large, rough-barked trees, such as old apple and pear trees, to coat all parts of the trees so thoroughly that no areas remain untreated. The operators of the nozzles may be unable, without a high tower, long extension rods and a very powerful pump, to reach the
upper branches or those in the center of the head; or the heavy spray mixture, though well distributed, may not penetrate beneath the protecting flakes of bark or into crevices where some scales may be hidden. If a special effort be made to cover large trees thoroughly, some damage is liable to be done to the buds especially if these are somewhat advanced, by the excess of the mixture which accumulates on the lower branches.

This was noticed particularly in an apple orchard near Geneva, in which the thinning of the fruit produced by bud injury was quite evident; but was more than counterbalanced by freedom of the fruit from scale and scab and by the improvement in size and color produced by the thinning. The sulphur-sprayed Greenings in this orchard averaged 694 apples to the tree, those not sprayed with sulphur 1529 apples; and the corresponding figures for the Baldwins were 1952 apples and 3404 apples per tree.

The fruit from representative trees in this orchard was carefully graded as to size as well as inspected for scab, scale and worm injury, one Greening and two Baldwins from each of the four sections being taken for this purpose. For comparison three divisions were made: Diameter greater than 3 inches, diameter between 3 and 2 3/4 inches and diameter less than 2 3/4 inches.

Those of the last size were considered seconds or culls, those of the other two sizes first class fruit. Graded in this way the check Greening tree gave 18.3 per ct. of culls; the tree sprayed three times with bordeaux and poison, 3.9 per ct. of culls; that sprayed once with sulphur and twice with bordeaux-arsenical mixture, 1.4 per ct. culls; and the tree sprayed but once with sulphur, 0.7 culls.

The Baldwin trees, bearing heavier crops of fruit, produced smaller apples, so that the percentages of culls were greater but the influence of the sulphur spraying showed even more plainly in its effect on the size. The two check trees averaged 25.8 per ct. of culls; the trees sprayed three times with bordeaux and poison, 28 per ct. culls; the sulphur-bordeaux-arsenical sprayed trees, 1.0 per ct. culls; and the trees sprayed but once with sulphur, 6.5 per ct. of culls. On the Greening trees less than 7 per ct. of the fruit exceeded 3 inches in diameter where the sulphur was not used; 24 per ct. of it where the sulphur was used.
None of the Baldwins on trees not treated with sulphur was above 3 inches in diameter; 11 per ct. of those on sulphur-sprayed trees exceeded that limit.

While the fruit from the trees in this orchard was in piles on the ground the improvement in size was noticeable; and the color of fruit coming from sprayed trees was also much superior in case of the Baldwins. This improvement in color was due principally to the prevention of scab and scale by the spraying; for the unsprayed fruit was, as a whole, much darkened by the unsightly scabbed patches and spotted by the red discolorations caused by scale. But on a number of sulphur-sprayed trees the hues of the fruit itself were heightened and made more brilliant, an effect undoubtedly due to the thinning.

Aside from the defects which are an invariable accompaniment of attempts to spray very large trees, the sulphur washes proved efficient scale destroyers on all treated trees. Even on badly infested large apple trees, standing beside other unsprayed trees and so near them that the laden branches interlaced thus making reinfestation very easy, the treatment gave fruit that was practically free from signs of scale, while on these untreated trees the fruit was so generally, and so badly, spotted that little of it was marketable. On peach, plum and cherry trees and on young apple and pear trees the scales were almost eradicated.

Owing to the wide distribution of the orchards under test, opportunity was given to note the effect of the sulphur wash upon many other insects. The work of the pear blister mite was far less noticeable on trees given thorough treatment with sulphur during the dormant season than it was upon the check trees or those sprayed with bordeaux and poison. In one orchard of young trees where comparison could be made with the treatment by hand picking of infested leaves continued through the season, the single spraying with sulphur gave better results. Hand picking is, at best, applicable only on small trees.

Promising results were also secured upon the pear psylla, as these pests were much reduced in numbers on sprayed trees during
the early part of the season. The attack of the psylla, however, was much less destructive than usual during 1904 in the orchards under observation, and the insects practically disappeared by midsummer; so that further work is needed before speaking with assurance as to the benefit of the sulphur treatment.

The orchard scurfy bark louse, except where the incrustation was very heavy, was almost entirely destroyed; the oyster-shell bark louse was reduced from one-half to two-thirds in numbers; and with the dogwood bark louse there was no increase of new scales, while the old scales were reduced 50 per ct.

Against the apple aphis, applications made before the buds started were without effect; but some delayed treatments, made when the buds were swelling, destroyed nearly half of these lice.

Against codling moth the application of sulphur during the dormant season of the trees was of little use. In one orchard where very careful observations were made on this point, the Greenings of Section I, where one application of the sulphur wash was made, contained 46.4 per ct. of wormy apples; in Section II, sulphur followed by bordeaux and poison, 9.8 per ct.; in Section III, check trees, 46.5 per ct.; while the trees in Section IV, receiving the usual three applications of bordeaux mixture and arsenicals, showed only 7.3 per ct. of wormy fruit. With Baldwins, 38.3 per ct. in Section I, 13.4 per ct. in Section II, 31.0 in Section III, and 6.8 per ct. in Section IV were wormy. By the use of arsenical poisons in the second and third treatments there was an average gain of 31.2 per ct. of sound fruit over the average of such fruit on check trees and trees treated with sulphur only.

In another orchard the percentage of sound fruit on the checks and sulphur-sprayed trees averaged 74.9 per ct. and on the trees where the arsenicals were used 95.7 per ct., a gain of more than 20 per ct. in favor of the poison spraying. It is obvious that any system of spraying apples, with the control of San José scale by sulphur washes as its main object, should also include the usual applications of arsenical sprays to prevent losses from the codling moth.
The observations made in this series of tests showed some very satisfactory results to prove the value of the sulphur washes as preventives of plant diseases.

In the orchards where peach leaf curl was a serious menace to the thrift and producing power of unsprayed trees, other trees that had received the early treatment with sulphur washes escaped with mere traces of the disease. On such trees a few leaves only on some of the twigs might show the curl while similar check trees were badly defoliated.

The results on apple scab were quite striking, the sulphur-wash alone reducing the percentage of scabbed fruit below that shown on check trees; and the sulphur wash followed by two applications of bordeaux and poison giving better results than the three applications of the regular fungicide-insecticide combination. As noted previously, the lessening of the amount of scab and scale marking improved the color of the fruit to a marked degree, especially on trees where the sulphur had been used before the bordeaux.

The table below shows, by figures from actual count of the fruit on 12 trees, how much the sulphur aided in the repression of scab.

**Effect of Sprays upon Apple Scab.**

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Percentage of scabby apples.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Greening</td>
</tr>
<tr>
<td>Checks, not treated</td>
<td>71.0</td>
</tr>
<tr>
<td>1 Sulphur wash</td>
<td>55.5</td>
</tr>
<tr>
<td>2 Bordeaux-arsenical</td>
<td>3.7</td>
</tr>
<tr>
<td>1 Sulphur and 2 bordeaux-arsenical</td>
<td>4.2</td>
</tr>
</tbody>
</table>

Averaging the results from the two varieties, one application of sulphur wash reduced the scab 22 per ct. below the percentage on the checks; and the one application of sulphur wash followed by two of bordeaux and poison reduced scab injury 7.8 per ct. below the percentage on fruit receiving the regular three applications of bordeaux and poison.

From these results it is believed that, for the control of apple
Check - No Treatment

Scabby
Not scabby

One Application of a Sulfur Wash
Scabby
Not scabby

One Application of Sulfur Wash and Two of Bordeaux-Arsenical Mixture
Scabby
Not scabby

Three Applications of Bordeaux-Arsenical Mixture
Scabby
Not scabby
scab, an application of a sulphur wash before the opening of the buds may be substituted for the usual spraying with bordeaux mixture at this time for the prevention of this disease.

Two formulas for sulphur washes were used in these tests.

Making and applying sulphur wash. (1) The lime-sulphur wash, of 15 lbs. each of lime and sulphur, is made by first slaking the lime to a thin whitewash, stirring in the sulphur until thoroughly distributed, and then boiling for one or two hours, adding water as needed to keep the quantity up to 50 gallons. This mixture has been uniformly effective in its operation.

(2) The lime-sulphur-caustic soda wash requires 30 lbs. of lime, 15 lbs. of sulphur and 6 lbs. of caustic soda, with 50 gallons of water. In preparing this the sulphur is made into a paste with 6 gallons of water and then poured over and well mixed with the lime. Water is then used as needed to keep the lime-sulphur material at the consistency of a rather stiff paste while slaking. When slaked, the full amount of caustic soda is added and the mixture stirred constantly until boiling ceases. As no boiling with outside heat is required in this process, the mixture is a little more convenient to make than the boiled wash.

Whichever wash is used it should be applied before the buds open, with a pump powerful enough to give a good spray and using towers, extension rods, etc., so that the entire tree may be covered with a thin, uniform coating.

In order to ascertain the average quantity of material used per tree and the cost of spraying, a large number of letters have been sent to practical spraying orchardists. From 150 answers to these letters, the following averages have been computed:

<table>
<thead>
<tr>
<th>Statistics of Spraying with Sulphur Washes.</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>No. and kind of tree.</strong></td>
</tr>
<tr>
<td>-------------------------------</td>
</tr>
<tr>
<td>4434 apple</td>
</tr>
<tr>
<td>5172 pear</td>
</tr>
<tr>
<td>4319 plum</td>
</tr>
<tr>
<td>19789 peach</td>
</tr>
</tbody>
</table>