SULPHUR SPRAYS FOR ORCHARD TREES.

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SULPHUR SPRAYS FOR ORCHARD TREES.

F. H. HALL.

Sulphur is quite well known as a destroyer of low forms of life. For years the Australian sheep-grower has found a dip including sulphur, one of the most effective remedies for certain parasites which trouble his flocks; the California orchardist uses a modification of the same mixture as his best resort when scales infest his orange trees; and recently, after some disappointments, the eastern fruit grower has learned that this same combination of sulphur and lime is his most dependable agency for the repression of that dreaded pest, the San José scale. Experiments along this line were reported in Bulletin No. 228 of this Station; and the practical experience of many orchardists in the State confirms the conclusion, drawn from the experiments, that the lime-sulphur-salt wash, or spray mixture, is a cheap, practical and effective agent for the control of scale insects on orchard trees.

The experiments reported in Bulletin 228 also gave some indications that this sulphur spray is effective against apple scab, a fungus disease; for the fruit from some of the trees sprayed with the lime-sulphur-and-salt mixture was practically free from scab.

* This is a brief review of Bulletin No. 247 of this Station on the Lime-Sulphur-Soda Wash for Orchard Treatment, by P. J. Parrott, S. A. Beach and H. O. Woodworth. 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.
while that from check trees was very badly effected. Experiments made elsewhere have proved that the same spray is efficient in controlling peach leaf curl; and it has been reported also, as preventing much of the injury from several insects beside the scales, among these being the codling moth.

Should these indications and suggestions of other uses for the wash hold good upon careful test, the mixture would be proven one of the most valuable in the list of orchard remedies; since the combination of fungicidal properties with power to destroy both sucking and biting insects would give to the sulphur spray a wide field of usefulness and might make it to a considerable extent a substitute for bordeaux mixture and arsenicals, as well as a destroyer of scale insects.

It was also thought, from work reported in Bulletin 228, that much of the time and labor necessary in making the California lime-sulphur-and-salt wash (which requires long boiling) might be gotten rid of by using caustic soda to induce the chemical changes, caused in the original method by the external heat.

A series of experiments was, accordingly, planned Experiments and carried out by the Station, to ascertain the outlined effect and value of the lime-sulphur-soda wash upon the San José scale, upon insects other than scales and upon diseases.

These experiments were located in four orchards, one in eastern New York, at Yorktown, one at Geneva and two at Carlton Station in Orleans County. These were commercial orchards, three of them well cared for and carefully treated in previous years to repress insects and diseases, the fourth one somewhat neglected, especially in the matter of spraying. The orchard at Yorktown has been infested with scale for several years and parts of it have been treated with hydrocyanic acid gas or with petroleum in an effort to control the pest. The orchard at Geneva and one of those at Carlton Station are also infested with scale, but not badly except on a few trees. The other orchard at Carlton Station showed no scale.

The experiments included 457 large apple trees, 245 plum trees, 338 pear trees, 375 peach trees, 26 quince trees and a few cherry trees. The test trees in each orchard were divided into
four sections, equalizing as far as possible the varieties and conditions in the different sections. Section I received one application of the lime-sulphur-caustic soda mixture during the dormant season of the trees; Section II received the same application, supplemented by two sprayings with bordeaux mixture and paris green after the leaves appeared; Section III was a check and was not treated; Section IV was given three applications of the regular bordeaux-arsenical mixture, one made before the buds opened, two after the leaves appeared.

The bordeaux mixture was prepared in the usual manner, by uniting a dilute solution of copper sulphate and a very thin whitewash. The formula calls for five pounds of the sulphate and from three and one-third to five pounds of lime in fifty gallons of water.

To each fifty gallons of the bordeaux mixture, one-half pound of paris green was added for use on apple foliage, but only half this amount on peach, plum and pear trees.

In making the lime-sulphur-soda spray, thirty pounds of lime, fifteen pounds of flowers of sulphur and four to six pounds of caustic soda were used to make fifty gallons of spray mixture.

The lime is slaked by the gradual addition of about six gallons of hot water. The lime should not become dry at any time nor should so much water be added at once as to "drown" it. While the lime is slaking, the sulphur, made into a thin paste with hot water, is slowly added and mixed thoroughly with the boiling, steaming lime. To prolong the boiling the caustic soda is then added, stirring thoroughly and adding more hot water if necessary to make a thin mixture. As soon as chemical action ceases, the required amount of water is added, and the material is ready to spray.

The process, except heating the small amount of water, can be carried on in a tub or half-barrel, and takes from ten to twenty minutes. When hot water is used, the full amount of caustic soda may not be needed, the six pounds being a maximum.

This process is much simpler than the old boiling method; but since the results are not quite so reliable, the old method is also given here for the benefit of those who prefer certainty at the
PLATE I.—EFFECT OF LIME-SULPHUR-SODA WASH ON LEAF-EATING CATERPILLARS AND ON SCALES: A, SPRAYED; B, UNSPRAYED.
expense of some time and labor. This mixture was not used in the tests.

The lime-sulphur-and-salt wash requires fifteen pounds each of lime, flowers of sulphur and salt to each fifty gallons of mixture. Slake the lime in a kettle (or vat, if steam is used) with hot water making an even white paste. Next add enough water to make a thin whitewash, stir the sulphur and salt into the whitewash, distributing them thoroughly, and boil all for one hour. If this is done in a kettle with fire it will be necessary to add water occasionally and to stir frequently to prevent burning and caking of the material on the sides of the vessel. Boiled with steam, such precautions are not required. After an hour's boiling, dilute with water to the required amount. If hot water is used, spraying can be begun immediately; but if cold water is added, the mixture should be brought to boiling before use.

Any lime-sulphur mixture should be carefully strained when it is poured into the spray tank, using a wire screen.

The sulphur mixture for the first treatment was sprayed on the trees in the different orchards between March 25 and April 2. The weather until toward the close of this period was bright and springlike, but later became cool and cloudy, with frequent rains. Heavy showers in the two weeks following the spraying made a severe weather test of the mixture. The trees were sprayed once carefully, and uncovered portions were treated again as soon as the first application dried sufficiently to show where the trees were not protected. Vermorel nozzles with fine apertures were used in all the work.

The bordeaux-arsenical applications were made as follows: (1) as the leaf-buds commenced to appear green at the tips; (2) just after the blossoms fell; and (3) from ten to fourteen days after the second treatment. In Section II in all the orchards, the application of the sulphur wash took the place of the first application of the bordeaux and poison.

In the Yorktown orchard, examination made late in September showed that the number of scales on the apple trees had been greatly reduced; although some trees which were badly infested and on which the bark was quite rough
PLATE II.—Effect of Lime-Sulphur-Salt Wash on Peach Leaf Curl and Scales: 1, Unsprayed; 2, Sprayed.
still showed many scales, and on three trees young live scales were found on the twigs and branches. In the first case the thick incrustation of scales and the roughness of the bark appeared to protect many of the scales from injury; while it was thought that the presence of the scales on young, smooth wood on a few trees, while they were usually killed under such circumstances, indicated a variation in effectiveness of the lots of mixture made at different times. As a whole, from 60 to 80 per cent. of the scales appeared to be destroyed on the apple trees; the fruit was, in the main, free from evidence of scale; and the foliage showed very little trace of them. On the pear trees from three to five per cent. of the fruit and foliage were marked with scale; while both fruit and foliage of the peach, plum and cherry trees were free from scales, and a very large proportion of the insects on the trees had been destroyed.

In the orchard at Geneva and the infested one at Carlton Station, which showed less evidence of scale injury than the Yorktown orchard, even better results were secured. In the Geneva orchard frequent examination failed to disclose any scales, and very few were found in the orchard at Carlton Station. In this orchard steam had been employed for about ten minutes in making the wash and appeared to increase its efficiency. One badly infested large apple tree was very carefully examined after treatment, and after long search only a few living scales were found on some of the branches. Out of nearly 8,000 fruits gathered from eight trees in this orchard, only eight infested specimens were found.

The Yorktown orchard is an old one, but has received careful treatment for control of the codling moth; while one of the Carlton Station orchards has had little, if any, treatment along this line; consequently each must be taken as a type and considered separately in discussing the effect of different mixtures on the codling moth.

At Yorktown the fruit from five trees in each treated section and from three check trees was examined, apple by apple, to detect wormy specimens. From this examination it was found that little reliance could be placed on the sulphur wash for con-
trolling the codling moth. The amount of wormy fruit where one treatment with the lime-sulphur-soda mixture had been made averaged 24.9 per ct.; on the check trees, 15.8 per ct.; where one sulphur spraying was followed by two sprayings with bordeaux and paris green, 7.1 per ct.; and where three applications of the bordeaux-arsenical mixture had been made, 1.3 per ct.

At Carlton Station, the percentages of wormy fruit were higher in all sections, as would be expected from previous lack of treatment. The sulphur-sprayed trees averaged 48.6 per ct. of wormy apples and the trees sprayed three times with bordeaux-arsenical mixture, 29.3 per ct.

Thus the tests in both orchards prove conclusively the superior merit of the bordeaux-arsenical combination for lessening the percentage of wormy apples through destruction of the young larvae of the codling moth. The effect upon the larvae which were dormant under the rough bark or in crevices about trunk and branches was not ascertained.

A rather surprising feature of the tests was the Results on effect shown in the neglected Carlton Station leaf-eating orchard, upon such early spring, leaf-eating caterpillars. erpillars as the bud moth and case-bearers.

Marked differences in the foliage were observed between check trees and trees treated with the sulphur wash. The photograph of typical leaves from trees in these two sections shows plainly that the sulphur spray has greatly lessened the injury, by caterpillars, to the first leaves. The difference was noticeable as late as June 9, but gradually became less as new leaves were unfolded. On May 5 a careful study and count of leaves on representative trees showed 74.2 per ct. of worm-eaten leaves on the check trees and only 25.8 per ct. on those sprayed once with the lime-sulphur-soda wash. On June 9, from 11 to 23 clusters of leaves, on each of six trees, were examined; and showed 71.7 per ct. of injured leaves on trees not treated with the sulphur, while the treated trees showed only 13.9 per ct. In the other orchards, owing to the previous good protection against insects, these early leaf-eating caterpillars were not numerous enough to be injurious.
The long-continued drought in the spring and the cold weather of early summer were unfavorable to plant diseases; consequently scab, pink rot, sooty blotch, peach leaf curl and other troubles of this class did no appreciable damage even on check trees. It will be necessary to continue the experiment to secure accurate information as to the effect of the sulphur sprays upon such diseases.

From these experiments, which give merely the **Conclusions.** result of one year's work, it appears: (1) That the lime-sulphur-caustic soda wash does not give as uniformly good results as the ordinary lime-sulphur-salt mixture prepared by the use of external heat. Variations in efficiency of the former wash seemed to be caused by differences in quality of the lime and soda used and the quantity of water employed. As some applications of this soda wash have been very efficient, future efforts will be directed toward ascertaining the causes of variation and securing uniformity of action; for the greater simplicity and ease of preparation make this wash desirable, especially for use in small orchards.

(2) One application of this wash greatly reduced the amount of injury from the early leaf eating caterpillars, like the bud moth, bucculatrix and case bearers.

(3) The wash is greatly inferior to the usual applications of bordeaux mixture and arsenical poison as a means of controlling codling moth. Indeed, it appeared to have no value for this purpose.

(4) While conditions were such that no data were obtained showing the effect of the wash upon plant diseases, experiments elsewhere prove that it will control peach leaf curl and indicate favorable action upon apple scab. Recommendations for its use along these lines must, however, be withheld until further tests can be made.