An Explanation of Recent Failures in San Jose Scale Control

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Extensive and repeated investigations have shown that orchards can be kept comparatively free from San Jose Scale by applications of lime sulfur, and that badly infested orchards can be redeemed and maintained in good condition by continued yearly applications.

However, more reports of unsatisfactory control of San Jose scale by spraying have been received by this Station during the past two or three years than formerly. Certain orchardists in southern Illinois have considered the present situation sufficiently serious to deserve special study. As parts of this study, the experiments already in progress are being continued and expanded, letters have been sent to a few workers in other state experiment stations asking for information regarding conditions in their localities, and a rather extensive correspondence has been carried on with some of the Illinois growers in various parts of the state.

Most valuable information has been obtained from the survey of commercial practice, and at this time only the conclusions drawn from the study of the facts furnished by the orchardists themselves are presented. Owing to the fact that the experiments are in an early stage, to present results at this time would be premature. The correspondence carried on with the authorities outside the state shows that the same difficulty is being experienced in certain neighboring states.

In spite of the large number of commercial successes obtained throughout the long period since the earlier experimental work was done, there have been occasional failures. It was not to be supposed, however, that the methods found successful experimentally would be followed exactly, or even approximately, in all cases by all growers; so that a certain proportion of failures was to be anticipated. The present investigation shows that in the amount of spray applied the deviation has been so extreme that the difference between the practices employed experimentally and those employed commercially, in this respect alone, can easily account for many failures. It does not seem to be necessary to assume that new or peculiar conditions are responsible for failure.
Conditions Necessary for Success

To obtain results in orchard practice similar to those obtained experimentally, the three following conditions must be fulfilled:

1. The diluted spray must contain 15 pounds of sulfur in 50 gallons.¹
2. The entire surface of the tree must be covered.
3. The trees must be heavily covered. The experimental work does not indicate that lime sulfur of the strength recommended will control San Jose scale if applied lightly, even if every part of the surface is covered.

Points Covered in Survey of Commercial Practice

The correspondence with the growers dealt with the more important factors in commercial spraying:

1. Materials used and concentration of material applied.
2. The use of the hydrometer.
3. Amounts applied.
4. Methods of application: that is, with guns or rods, with high or low pressures, with nozzles having large, medium, or small holes; with the wind; from towers, with high or low capacity rigs; with or without close supervision.
5. Opinion of growers as to cause of failure.

An important fact brought out by this correspondence was that practically all the failures have been experienced by growers in the southern third of Illinois, none were reported from the northern third, and very few from the central third. This can be easily explained, for the more favorable temperatures of southern Illinois result in the development of a greater number of broods, therefore very greatly increasing the infestation. Moreover, it has been observed that low winter temperatures, experienced more frequently in northern Illinois, result in the death of many of the insects. The experimental work has shown that heavy infestations are controlled with much more difficulty than light ones.

Variation in Strength of the Diluted Spray

The correspondence shows that orchardists in northern Illinois are using with success methods which are utterly impossible in the southern part of the state. In the northern counties, failure properly to dilute the spray solution is common. The dilution recommended for lime sulfur made according to the 50-100-66 formula (the formula most commonly used in northern Illinois) is 1 to 4.² Much weaker solutions are usually made. In one case the material was used at the rate recommended for the commercial solution, that is, at a dilution of 1 to 8; resulting in a spray about one-half as strong as the Illinois Station has been accustomed to consider safe. In spite of these weak solutions, the growers using them have been continuously successful. The point must be kept in mind that these were northern Illinois growers.

¹This is obtained approximately by diluting commercial lime sulfur, testing 33° Baume (1.29 specific gravity), 1 to 8; by diluting homemade lime sulfur made by the 50-100-66 formula, testing 23° Baume (1.19 specific gravity), 1 to 4; or by diluting homemade lime sulfur made by the 50-100-50 formula, testing 28° Baume (1.24 specific gravity), 1 to 6.
In southern Illinois the formula now most commonly used is the 50-100-50 formula, this having displaced the older 50-100-66 formula. Moreover, practically all the growers are using more of this stronger solution (usually about one-fourth more) in making the diluted spray, than the recommendations of the Experiment Station call for. The difference between the strengths of spray used in the two parts of the state is striking, and there can be no doubt that this difference has been brought about gradually by the differences in the difficulty of control.

**Amount of Spray and Thorniness of Covering**

The most important questions have proved to be those dealing with the amount of spray applied and the thorniness in covering the tree. Investigations conducted by the Oregon Experiment Station\(^1\) show that for trees between eleven and seventeen years of age the following amounts are required for the best results from dormant spraying:

<table>
<thead>
<tr>
<th>Orchard</th>
<th>Gallons</th>
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<tbody>
<tr>
<td>Eleven years old</td>
<td>4.1</td>
</tr>
<tr>
<td>Twelve years old</td>
<td>4.5</td>
</tr>
<tr>
<td>Thirteen years old</td>
<td>5.6</td>
</tr>
<tr>
<td>Fourteen years old</td>
<td>7.0</td>
</tr>
<tr>
<td>Fifteen years old</td>
<td>7.2</td>
</tr>
<tr>
<td>Seventeen years old</td>
<td>8.0</td>
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</tbody>
</table>

Assuming that the amount required increases with the age of the tree from seventeen to twenty-five years at the same rate that it does for trees between eleven and seventeen years, the amount required at twenty-five years would be, according to the Oregon figures, between 13 and 14 gallons.

Experiments conducted by the writer at Urbana indicate that even when conditions most favor the efficient application of the spray, it is necessary to use the above amounts to secure heavy and complete covering. According to information received from the growers the amount most frequently applied to twenty-five-year-old trees in this state is 5 gallons. It is likely that the most important cause of failure lies right here. Certain successful growers in the region where scale is hardest to control believe that 25 gallons is not too much for a tree of this age.

The writer does not mean to state definitely that the scale cannot be successfully controlled when the trees are covered with smaller quantities, but he does desire to state definitely that small quantities of lime sulfur of standard strength have resulted, and always will result, in failure in regions where conditions are likely to make control difficult. Under conditions which do not render control difficult smaller amounts evidently are sufficient.

**Methods of Application**

Methods of application have received particular attention recently. Western orchardists are emphasizing the importance of high pressure more than are the eastern orchardists.

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The reason for considering pressure is that high pressures facilitate application by breaking the spray into fine particles. The ideal spray is a floating, fog-like mist. Another important condition governing the size of the particles is the size of the holes in the disc; the smaller the holes the finer the particles. Rods, therefore, equipped with nozzles having finer holes than guns can be used when the pressures are too low for guns. One gun only, it is claimed by western growers, can be run to advantage with power sprayers having engines of $3^1/2$ or 4 horsepower; two guns can be run satisfactorily only with engines of 8 or 10 horsepower and correspondingly large pumps. It is essential that the pump be of such a capacity that large quantities of material will flow back into the tank. On small outfits (or outfits which are being run, for some reason, below capacity) rods should be used. By giving attention to the size of the holes in the discs, these rods can be made to give as good results as guns run properly. The total expense, however, is greater. It was found that in Illinois pressures between 150 and 350 pounds are being used with the guns; only one grower reported the use of a rig having an 8-horsepower engine. The material is most often applied with two rods, or one gun and one rod, to a rig; although two guns, or one rod and one gun, or two rods and one gun, or one gun alone are also used. Thus there is considerable variation in the machinery used, but there seems to be little variation in certain other factors which might govern the efficiency of the spray. Towers are used ordinarily, most growers spray with the wind, and most growers spray in the spring or late winter.

Opinions of Growers as to Causes of Failure

Interesting and instructive conclusions can be drawn from the almost unanimous opinion of orchardists as to the cause of failure. Almost without exception failure was thought to be due to imperfect covering. Some very strong letters dealing with this point were received from growers, stating that with proper covering there could be no failures. This indicates that in their opinion proper covering and the use of large amounts are synonymous. Many growers indicated faulty dilution as a cause of failure, while only two held that climatic conditions were partly responsible. There seems to be reason for believing that the fault in most cases lies in the application of insufficient amounts of spray, and not in the use of too weak solutions. Climatic conditions may also explain some local variations as well as state-wide differences.

Conclusions

The most important points brought out by this study are the following:

(1) Failures are common in southern Illinois but are the exception in northern Illinois.

(2) Growers throughout the state are spraying their trees with very small quantities in comparison with the amounts used experimentally. The amount of spray most often applied seems to be about one-third that required to cover the trees heavily.

(3) While the use of these small amounts does not seem to cause trouble in northern Illinois, it is the most likely explanation for the failures which are occurring in southern Illinois.