The San Jose scale on a peach twig, magnified. Often entire trees are covered by the pest.

The Control of the San Jose Scale in Missouri

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COLLEGE OF AGRICULTURE
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CONTROL OF THE SAN JOSE SCALE IN MISSOURI

L. HASERMAN

With the passage of the Nursery and Orchard Inspection Act of 1913, the Missouri Agricultural Experiment Station was placed in charge of the inspection of nurseries, orchards and other grounds which may harbor insect pests and diseases, dangerously injurious to agriculture and horticulture. The Agricultural Experiment Station was authorized not only to inspect infested grounds, but also to assist with the cleaning up of insect pests and diseases where found.

The San Jose scale being the one insect pest of most vital importance to horticulture in Missouri, steps were taken at once to assist with the cleaning up of this pest. In the past, a great deal of nursery stock infested with the scale, was distributed in Missouri, but with the more rigid inspection of all nursery stock grown in the state and with full supervision over the importation of stock from other states, it is now possible to prevent further spread of the scale in this way.

In the summer of 1913 thirteen of the smaller nurseries were found to be badly infested and others were found to have some infested stock. The nurserymen were all required to destroy all stock visibly infested and fumigate the rest of the stock before it could be distributed. In this work the nurserymen heartily cooperated. They uniformly show a disposition to take all necessary precautions to stamp out this pest once the proper methods are made known to them. Of the nurseries found infested nearly all were supplying local demand and had not previously been given the annual inspection. In 1914 a few of the nurseries were found to have some scale and the same precautions as in 1913 were taken. In most of these cases the nurseries had not previously been found to be infested. With full authority to condemn all infested stock, and with the energetic cooperation of the nurserymen, which has been secured, it is possible to prevent its further spread on nursery stock and the inspectors can direct their efforts to the control of the pest where it is already found.

HISTORY OF THE PEST IN MISSOURI

The San Jose scale was first introduced on nursery stock from the east between 1890 and 1895. It was first discovered in St. Louis, Randolph, Carroll, Jackson, Cole, Webster, and Cape Girardeau coun-
ties. The pest spread rapidly in spite of efforts made to check it. Further shipments of infested stock were sent in and the local distribution of the pest continued.

Renewed efforts to check the pest were made by the entomologists of the Missouri Agricultural Experiment Station and the Fruit Experiment Station in 1907 and 1908. Experimental work with sprays was carried on and a number of spray demonstrations were made in the infested sections of the state. It was in connection with that work that the real seriousness of the scale situation was first determined. The pest had already spread to one-third of the counties of the state.

Present Distribution. At present there probably is not a single county in the state in which some scale cannot be found. In twenty years this pest has covered the state and practically annihilated fruit-growing in some sections. It is time, therefore, that definite steps be taken to check the scourge and secure the cooperation of all farmers and fruit-growers for its control. The pest is not only destroying orchards completely but in less severely infested orchards much of the fruit is so severely blotched that it is of no commercial value. There has been much blotching of fruit due to the attack of the scale during the past year.

In order to complete the records of the distribution of the scale in the state, the Agricultural Experiment Station is especially anxious to learn of any outbreaks of the pest which may be present in the following counties: Adair, Andrew, Atchison, Barton, Benton, Bollinger, Buchanan, Caldwell, Carter, Cass, Cedar, Christian, Clay, Clinton, Crawford, Dallas, Dent, Gasconade, Gentry, Grundy, Harrison, Hickory, Holt, Iron, Johnson, Laclede, Lafayette, Lewis, Livingston, Maries, Mercer, Miller, Moniteau, Montgomery, Monroe, Nodaway, Osage, Phelps, Polk, Putnam, Ray, Reynolds, Schuyler, St. Francois, Stone, Sullivan, Warren, Worth.

DEVELOPMENT OF THE SCALE

This scale insect is very prolific. It matures rapidly and gives birth to its young. In this way it soon encrusts and destroys a tree. The pest winters as an immature insect beneath its black armor, which is about the size of a fly speck. As soon as the sap begins to rise the pest resumes feeding by extracting sap from the bark thru a slender sucking tube. It matures in about a month. During the summer several generations are produced and since the pest is so well protected by its armor it is able to escape the attack of natural enemies and soon completely encrusts a tree.

For a time after birth the young insect moves about like a small, red chigger, but when it begins to extract sap it begins to secrete its
armor, sheds its appendages, and becomes a small animated pump. The female never leaves the place where it begins to feed. The male, when mature, emerges and flies about.

**How to Determine the Presence of the Pest.** The San Jose scale will attack more than one hundred different kinds of trees and shrubs, but it is most often found on apple, peach, and pear trees and on currant and fire-bush. When it first begins to appear on a tree it is difficult for one to detect it, for the small gray circular armors are no larger than a pin-head. A bad case of encrustation should be readily seen by any fruit-grower, for the armors form a scurfy covering over the bark. By running a knife blade or finger nail over an infested limb a yellow liquid, from the crushed bodies of the insects, appears. Many fruit-growers first find the scale on the fruit by the red blotching which develops about the point of attack. The blotch is deep red in color with a light spot in the center and may vary in size from a mere spot to a distinct blotch. The pest seemingly injects poison while extracting sap, which causes the red blotch.

All trees and fruit should be carefully and frequently examined and in all cases where there is any question about the presence of the scale in an orchard, samples of bark, twig and fruit should be sent to the Missouri Agricultural Experiment Station at Columbia, for examination. It is a waste of time and material to spray for the scale where it is not present and it is expensive to let an orchard go unsprayed where the pest is present, so make sure about the presence of the pest first.

**REMEDIES**

So far as our present knowledge goes there is only one practical method of successfully combating this pest in the orchard. This consists of the application of a strong spray during the dormant season.
At that time it is possible to use a spray of sufficient strength to kill the scale beneath the armor and yet not injure the tree. Summer spraying has been tried but it is not effective. Fumigation is practical in case of infested nursery stock but it is not advisable in a bearing orchard. By cutting out and burning infested trees the pest can be destroyed, but where the pest is common in a community this is not advisable. If the pest is found when first introduced into a new locality the destruction of all infested trees is a practical means of getting rid of it.

\[\text{The San Jose scale on an apple, natural size. They collect for protection about the blossom end. A small red blotch appears where each scale inserts its beak.}\]

Spraying for Scale. There are two types of scale washes, lime-sulphur and oils. Some prefer the former, others the latter. For scale alone either is entirely effective, tho the lime-sulphur possesses fungicidal properties which the oils do not. In a neglected orchard where not only scale but other insects and diseases are to be controlled, the lime-sulphur will give the greater returns.

If a grower is properly equipped for preparing his spray materials at home he can do so for less than commercial preparations will cost, but where only a small quantity is needed or where the grower does not have the necessary equipment it is better to simply secure one of the standard high-grade commercial brands.
To prepare the homemade lime-sulphur slake 20 pounds of lime and add 15 pounds of sulphur to the slacking lime and enough water to prevent burning. If live steam is available the material can be boiled in a barrel, tho a large cooker or kettle will serve the purpose where external heat is used. Boil for an hour, strain and dilute to 50 gallons and apply while yet warm.

To prepare homemade concentrated lime sulphur, the grower may use one of several formulae. Some recommend the following formula:

- Fresh stone lime ............... 40 pounds
- Sulphur .......................... 80 pounds
- Water ............................ 50 gallons

In the preparation of this solution slake the lime and add the sulphur as in making homemade lime-sulphur. Stir constantly and boil for an hour, adding water as needed to keep the solution up to 50 gallons. The concentrated solution may be diluted and used at once or stored for later use. To determine the amount of dilution, one should have a hydrometer made especially for testing lime-sulphur. The solution ready to apply for the scale should give a specific gravity reading on the hydrometer of about 1.03. To reduce the concentrated solution prepared as directed above, dilute at the rate of one gallon of the concentrated solution to about 5 gallons of water. As standard brands of commercial lime-sulphur are more concentrated than the homemade solution under consideration, where they are used the dilution should be at the rate of one gallon of the solution to about 8 gallons of water.

A homemade oil emulsion can be made very simply by boiling 2 pounds of hard soap in 4 gallons of water until all is dissolved. Then pour the four gallons of boiling suds into the spray barrel containing between 8 and 10 gallons of coal oil. Agitate by pumping the solution thru the nozzle back into the barrel until the oil is thoroly broken so that it will not separate on cooling. Then add enough water to make 50 gallons before applying. If a standard commercial miscible oil is used it should be diluted at the rate of one gallon of the solution to from 12 to 15 gallons of water.

In the control of the scale thorø application is most important, since the scale must be touched if it is to be destroyed.

RESULTS OF SPRAY EXPERIMENTS AND DEMONSTRATIONS FOR CONTROL OF SCALE

During 1913 and 1914 the departments of horticulture and entomology cooperated in carrying out extensive spray experiments and demonstrations for the control of San Jose scale and other insect
pests and diseases of fruit. A report of the work for the scale will be included herewith. The results of the summer work for fruit insects and diseases will be given in a separate report. Mr. T. J. Talbert, formerly assistant in entomology, did most of the spraying work in connection with these investigations.

Spraying work was done in six different orchards, two at Willard, one at Sikeston, one at Jackson, one at Boonville and one at Hannibal. In each case but a few trees were used, the rest of the orchard being treated by the grower. Commercial lime-sulphur and scalecide were the only sprays tested and the latter was used in only one orchard. The work was not planned for making a study of the comparative value of different sprays but rather to show the proper methods of spraying for scale, to compare the results of fall, winter and spring applications, to determine the possibility of controlling the pest in a badly infested orchard so that it will not blotch fruit and also to determine the feasibility of combing the cluster-bud spray with a late spring application for scale, thereby making a single application of a concentrated scale spray just as the buds are opening.

Sikeston Orchard. Twelve large bearing trees in the home orchard of J. L. Tanner were used in this experiment. The trees were between 15 and 18 years old. Some were badly encrusted with the scale and some limbs had already been killed by the pest, tho most of the trees were thrifty. The trees were tall and were not pruned before the sprays were applied.

Six trees were treated with commercial lime-sulphur using 6½ gallons of lime-sulphur in 50 gallons of solution and six were treated with scalecide using 4½-6 gallons of scalecide in 50 gallons of solution. The spray was applied in November and a barrel pump was used. About eight gallons of solution were applied to each large tree. The cost of material per tree was $0.12½ in case of lime-sulphur and 32 cents in case of scalecide.

Results. The trees were examined in September, 1914, and the scale was found to be under control, tho in many cases the scales on the tips of twigs had escaped the spray and some of the fruit was found to be severely blotched. As a result of the demonstration and the excellent work of Mr. H. B. Derr, farm adviser, 15 sprayers were purchased and 2000 infested trees in the vicinity of Sikeston were treated for scale. An earnest movement is now on foot to control the pest in Scott county.

Willard Orchards. A portion of two orchards were sprayed at this place. In the orchard of E. E. Greenwade, 25 large apple trees, about
25 years old, were treated with a power sprayer and commercial lime-sulphur diluted 1 to 8. The trees were less severely infested than those at Sikeston. Eight gallons of solution were applied to each tree. The cost of material per tree was 12½ cents.

**Results.** The scale was very successfully controlled, not only on the main limbs, but also out to the tips of the twigs. Only an occasional blotch was found on the apples, while the apples on check trees were badly blotched.

In the orchard of G. K. Murray, 50 twelve-year old trees were treated. The infestation was light and the trees thrifty. A power sprayer was used and the spray applied as the buds were opening in the spring. The first leaves were about the size of squirrel ears, tho the blossom clusters were not yet out. Commercial lime-sulphur was used at a dilution of 1 to 10, and 5 gallons of solution were applied to each tree. The spray was used to control the scale and also to take the place of the regular cluster spray. The cost of material per tree was 6½ cents.
Results. For a few days the burning of leaves was very pronounced, but a splendid crop of fruit set. The scale was controlled perfectly and the scab was as well controlled as where the regular cluster spray was applied.

Spraying with a concentrated spray after the buds begin to open cannot be recommended for general practice until further careful observations are made.

Jackson Orchard. Twelve large bearing trees were treated. They were badly infested, some having dead limbs as a result of the work of the pest. The trees were from 15 to 18 years old. A barrel sprayer and commercial lime-sulphur diluted 1 to 8 were used. About five gallons of solution were applied to each tree. The cost of material per tree was 74-5 cents.

Results. In this orchard the results were not entirely satisfactory. Considerable blotching of fruit occurred, tho not nearly so much as on the unsprayed trees. The scale was checked, tho not so well controlled as should be expected where the dormant sprays are applied.

Boonville Orchard. Two separate experiments were made in the orchard of P. R. Jaeger. The trees were large and very severely encrusted with scale. A barrel sprayer and commercial lime-sulphur were used.

In December 10 trees were treated with lime-sulphur diluted 1 to 8. Five gallons of solution were applied to each tree. In the spring just as the leaves began to show these ten trees and ten additional ones were sprayed with lime-sulphur 1 to 8. With this application 6¾ gallons were applied to each tree. The cost of material per tree, where winter and spring applications were made, was 17½ cents, where only spring application was made 9¾ cents.

Results. The results in this orchard were excellent. There was some blotching of the fruit where only one application was made, but where the two applications were made the scale was completely controlled.

Hannibal Orchard. Thirty-six trees in the orchard of J. G. Dameron were treated with lime-sulphur early in March. A barrel sprayer was used and the lime-sulphur diluted 1 to 8. The trees were 12 years old and slightly infested. About four gallons of solution were applied to each tree.

Results. The scale was quite well controlled, tho some apples showed scale blotches. The last summer seems to have been especially
favorable for the development and spread of the San Jose scale. Where spraying was not done with the greatest care so that practically every scale was destroyed, the pest developed rapidly and reinfested the trees.

**SUMMARY**

From the results secured in these experiments it has been found that in case of a badly infested orchard, two applications are required, one in the late fall and one in the spring before the buds open. Where but one application is made equal results may be expected from a late fall or an early spring application.

Further experiments are necessary before it is safe to recommend a combination scale and cluster spray as the buds are opening in the spring.

So far as the control of the San Jose scale alone is concerned, lime-sulphur and commercial miscible oils seem to give practically the same results. Thoroness is all-important and a large bearing tree will require from 5 to 10 gallons of solution for a thoroto application.

For badly infested trees most thoroto spraying is necessary in order to control the pest so that it will not blotch the fruit.

This pest can be easily controlled at slight expense and every farmer or fruit-grower should secure a sprayer to suit his needs, buy or prepare his spray materials as directed, select the most favorable time in late fall or early spring and spray thoroly. One can no more expect to gather good clean fruit from an orchard in this state without spraying than he can expect corn without cultivation.