

OKLAHOMA

AGRICULTURAL EXPERIMENT STATION

BULLETIN NO. 79, APRIL, 1908.

San Jose Scale in Oklahoma.

By

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THE SAN JOSE SCALE (ENLARGED)

Stillwater, Oklahoma.

AGRICULTURAL EXPERIMENT STATION

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EXPERIMENT STATION, Stillwater, Oklahoma.

BULLETIN

OF THE

Oklahoma Agricultural Experiment Station

NUMBER 79.

APRIL, 1908.

THE SAN JOSE SCALE.

The San Jose Scale has become a pest that must be immediately dealt with by the fruit growers of Oklahoma, if it is not to become as destructive here as it is in some of the Eastern states. Since it was first found in Oklahoma in 1897 by E. E. Bogue, this insect has not spread far from the point where it was discovered, but many new infestations have been found. Many of these newly found foci have been present for several years, and only awaited discovery. This indicates that even now there may be more San Jose scale in Oklahoma than that recorded. Portions of the state have been quite thoroughly examined, but there is need of a more extended investigation, especially of the orchards. The Nursery Inspection Law enacted by the Territorial Council in 1905 gave the Entomologist the opportunity to thoroughly examine the nurseries in the state, but gave no authority or opportunity to investigate the orchard conditions. These facts, added to the other one, that the Indian Territory side of the state has never had any investigational work, makes it certain that more San Jose Scale infested districts exist than those recorded. There is enough scale in Oklahoma that we know about at the present time to cause the fruit grower to seriously consider any measures that might be adopted to control this pest. The nurserymen are frequently the agents who introduce this pest into new districts, and laws regulating the importation of nursery stock cannot be too vigorously enforced. The nurserymen, frequently find that the orchards near their nurseries are the sources of infestation

and they should have the right to see that these orchards are freed of this insect. What is needed is a law that will force vigorous treatment of this pest wherever found in the state. Laws giving the state complete control of the situation, are in force in nearly every state where this insect is abundant.

ITS HISTORY IN OKLAHOMA.

The following, taken from Oklahoma Bulletin No. 34, published in May 1898, gives the early history of this pest in Oklahoma:

"Its presence had not been known until June 1897, when Mr. W. T. Harness of Lexington, sent infested twigs and leaves to the station for information in regard to the insect. On June 18, 1897, Mr. Harness' orchard was visited and about fifty plum and peach trees near the house were found to be badly infested. Mr. Harness planted his trees in 1891 but he did not discover the scale until the winter of 1896-7. At this time he supposed the scale was introduced into his orchard on house plants or ornamental shrubs."

From 1898 to 1905 no work was done with this pest in Oklahoma, aside from the spraying of the trees in the above mentioned orchard. The Station had no funds that could be devoted to an investigation of the pest in other parts of the State and so the history of the insect, so far as it concerns Oklahoma, is incomplete. In May 1905, the legislature put into effect an act relating to insects and diseases which are injurious to growing crops, nursery stock, fruit and shade trees, bushes, shrubbery and vines, grains, fruits, and vegetables; providing for the establishment and maintenance of quarantine regulations for the purpose of preventing the introduction and dissemination of the same; for the inspection of nurseries and the regulation of nursery agents. By this act the Entomologist of the Experiment Station became the duly authorized inspector, which gave him an opportunity to make quite a thorough canvass of the state and to look for any San Jose Scale districts in and around the nurseries. By this means, the insect was found firmly established in several widely separated places in the state. The known districts were increased in number by parties sending to the Station specimens of the insect for identification. While these records are far from complete, and do not give the definite distribution of this pest in our state, still they are valuable in that they give a clue to the conditions now existing. They show a distribution, which indicates that there may be many infested regions yet undiscovered.

The San Jose Scale has been found and personally examined by the writer at the following places:—Shawnee, Yukon, McLoud, El Reno, Mulhall, Wellston, Warwick, Norman, and Wagoner. In each

of these places the scale is largely confined to the city fruit trees. In very few cases could it be found in the orchards of the surrounding country. This would indicate that the pest has been introduced from foreign nurseries. The trees in a city represent dozens of nurseries, and many of them are fancy varieties obtained for novelty rather than utility. These latter are frequently passed between nurserymen and the chances for their becoming infested with San Jose Scale becomes thus greatly increased. The cities offer the best means for dissimulation of the pest. Birds are numerous in the cities, especially the English sparrow, and these are efficient agents in carrying the young scale. The scale has not been found in any of the nurseries of Oklahoma, but as a precaution those nurserymen located near infested regions fumigate all their stock before shipment, rendering it absolutely safe so far as this pest is concerned.

What the future of this insect will be in Oklahoma if no effort is made to stamp it out in its infancy, can be readily determined by turning to its history in the Eastern States. It is a serious pest, and one capable of driving the fruit industry out of the state.

DESCRIPTION OF THE INSECT.

APPEARANCE ON THE TREES.

Trees slightly infested with this insect may be overlooked by the ordinary fruit grower on account of its small size and color, the latter closely resembling the bark of the tree. When the insects are in large numbers, and an incrustation is formed, they can be readily recognized. The tiny twigs and branches infested take a grayish, shiny appearance, quite unlike natural bark. This upon close examination reveals the true nature of the insect. The scale coverings are all that are visible, for the insects themselves are yellowish or pale orange, very flat and oval in shape, and rest beneath the scale cover. These scales are nipple shaped. The larger ones are easily seen with the naked eye. The smaller may be invisible without the aid of a hand lense. The Frontispiece shows the appearance of a heavily infested twig, as seen under a glass magnifying 20 times. Scales of all sizes are visible, some darker than others, but all with the characteristic nipple appearance. By scraping the twig with the thumb nail, the scales can be dislodged and the yellow bodies of the insects become visible. By pressing and drawing the back of the thumb nail down over the twig, a yellow oily liquid will come to the surface, indicating the presence of the insects below the scale. The scales are not confined to the trunk and twigs, but will spread out over the leaves and fruit during the summer months. On the leaves they may be difficult to find, due to their small number, but when they settle

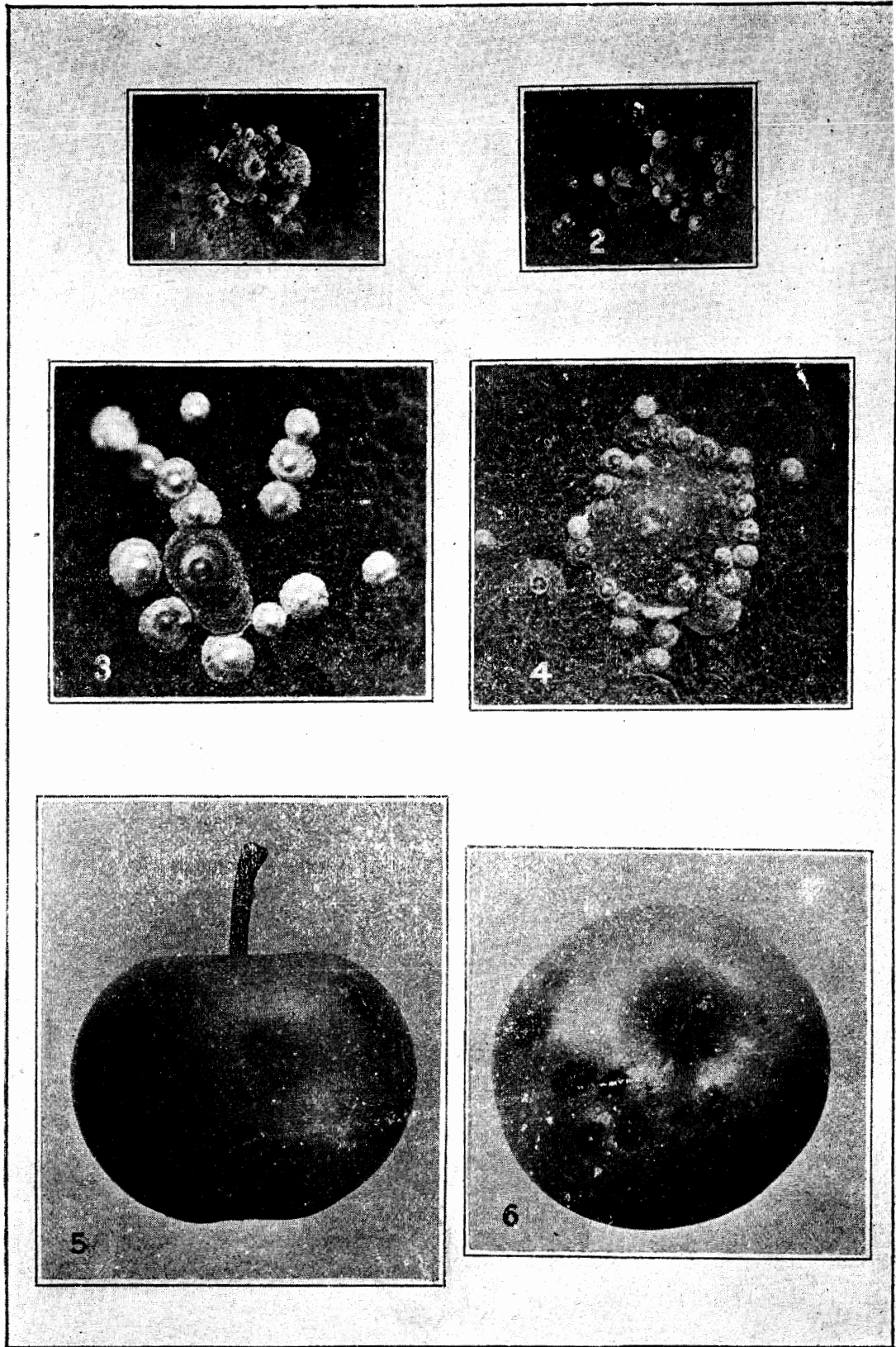


Plate I. 1, 2 and 4 Female scale with young. 3, male scales. 5, scale natural size. 6, Discoloration caused by scale. (N. Y. Geneva Bull. No. 193.)

down on the fruit a red spot appears under and around the insect. These red spots are very characteristic, especially on peach, and their presence, together with the tiny scale stationed in the center, is almost sufficient proof to declare the trees infested. The apples in Plate I show the characteristic spotting of the fruit caused by this insect. The spots are reddish, and contain gray centers which latter are the scales themselves. On young tender twigs and leaves, especially of the peach, the scales will cause a reddish discoloration for some distance around them.

More will be said later regarding the detailed appearance of the scales. With this description one ought to be able to recognize this insect upon his trees or shrubs, even if in small numbers. There are many other scale insects that infest the fruit and shade trees, but none of them have all the above characteristics.

MICROSCOPICAL APPEARANCE.

The name "scale insect" is given to this pest because throughout its complete life, with the exception of a few hours after birth, and in the case of the male, a few days after maturity, they are covered with a scale. The scale or covering is composed of cast-off skins and secretions from the body of the insect. This structure is firm and waxy and offers almost a complete protection for its occupant. Rains, and even weak insecticides, have no effect upon the structures and it is only by the use of strong corrosive agents that the insects can be destroyed. The color of the scale covering changes from youth to maturity. When the young insect first begins to form the covering, the latter is almost white, at half size nearly black, (a characteristic not met with in other scale insects), and at maturity dark gray. The color of the mature cover is not uniform as can be seen in Plate I. The center is elevated and appears lighter, the groove around it appears black, while the remainder is grayish in color. These coverings adhere closely to the bark around the insect. In some of the other species of scale insects the coverings appear loose and are easily dislodged. This is especially characteristic of the Scurvy Bark-louse.

By inserting the point of a pin or knife-blade under one side of the covering the latter can be tipped back, revealing the true insect below. This flat, yellow, footless, oval insect derives its nourishment from the tissue below it. It has no head proper, but a long sucking tube, which it inserts into the soft tissue early in life. When it thus attaches itself to a particular spot, it remains there permanently. The covering is soon formed, which in itself prevents any movement from place to place. This sucking process, while not injurious when confined to one insect, becomes a serious thing for

the tree when thousands of the tiny pests are all industriously doing the same thing. The insects become footless, blind and devoid of all appendages, for the reason that there is no work for those organs to perform.

The female appears to be a lifeless patch of yellow, still so far as her life processes go, she is extremely active. The young scales are very active shortly after birth, usually for 12 to 36 hours. They can be seen with the unaided eye, during the summer, crawling over the infested trees. They are nearly as small as the point of a pin, but bright yellow in color and not hard to see. At this stage they possess eyes, antennae, and legs but no covering. It is not until they settle down, and insert their long thread-like beak into the tissue that they lose their appendages and begin to invest themselves with the scale covering. The males appear much like the females until nearly fully matured. The bodies of the undeveloped male insects under the scale covering are a little longer but not very different in general appearance. When matured, however, the males, at the last molt, became greatly changed. Instead of an inactive, unappendaged insect, he becomes a two-winged active one. The old scale covering is left when this happens, and the tiny male seeks the females which latter remain under their coverings. The males may be seen during the summer if badly infested trees are closely examined.

No true eggs are deposited by this insect. Unlike the majority of the native scale insects, the female San Jose Scale gives birth to living young. The young are immediately active, and leave the mother scale covering immediately after birth and seek a place to establish themselves. The young during this stage, are transportable and may be carried from tree to tree by insects, birds or winds. If an adult female insect is examined under a high magnification the oval bodies of the young may frequently be seen within.

LENGTH OF LIFE CYCLE.

The life cycle from birth to death is short, thus giving possibilities for large numbers to be produced in one season. While the temperature may accelerate or retard the rate of development the whole time may not consume more than ten weeks. From four to six weeks is the time generally given by the best authorities for the insect to reach maturity and begin the process of producing young. The reproductive process extends then over about six weeks. It only requires a few days after maturity is reached for the female to become fertilized, and young produced. Since the young develop so rapidly and the time of reproduction extends over such long periods, it is not strange that scales of all sizes are soon found upon the

trees. The number of young that a female may produce is very variable. Lowe and Parrott at Geneva, New York, found the highest number that a female would produce to be only 88, while Wilmon Newell of the Louisiana State Crop Pest Commission, Circular No. 4, gives the number from 150 to 500. These latter figures are the ones used by Dr. Howard, of the Department of Agriculture, in estimating the number of progeny that may arise from one pair in one season. The enormous number of 3,216,080,400 has been given by him as the number that may be present at the end of the season, if all the individuals of all generations found food and lived. Fortunately there are many factors present to prohibit the realization of these possibilities, but it gives cause for alarm, and explains the insect's power to cause such great damage.

Observations made by the writer during the past year indicate that the female suspends the operation of giving birth, for only a few weeks during the year. Young active scales have been found during warm spells in November and December. Also in February and March. It is possible that the operation is only suspended during cold spells, and that the female resumes her duties upon the advent of a favorable temperature. If these observations are accurate, and a true indication of what takes place on a large scale, it means the possibilities for a greater development of individuals and their wide distribution. It is during the fall and spring months that the nursery stock is moved over the state and if young active San Jose Scale insects are present at these times, they find an easy means of distribution.

HABITS AND METHOD OF CONTROL.

AMOUNT OF DAMAGE.

The amount of damage that this insect has done to the fruit industry of the United States in the past few years is enormous. So great are the losses that every fruit growing state has enacted some special legislation directed toward the destruction of this pest. In Oklahoma the amount of damage that is directly chargeable to this insect is not great. The losses are increasing, however, and in several orchards where two years ago this pest could have been removed at an expense of a few dollars, it cannot now be eradicated without practically destroying the orchard. The insect does its notable damage upon the younger twigs. It may be found upon leaves and fruit, causing these to become deformed or knotty, but their presence on the twigs generally so injures these parts that they die back. The sucking of the juice is only a part of the damage that they do. The insects poison the surrounding tissue as indicated by the discoloration.

Many of the more hardy trees will not succumb to this pest for many years. For example, apple and pear trees may live for many years after infestation; but during the period the tree is infested, its usefulness, as a fruit tree, has been seriously impaired, if not entirely destroyed. Peach and some varieties of plum have been found to be destroyed in from two to three years by the San Jose Scale in Oklahoma. Some of the forest trees may harbor the scale but never die from the injuries of the insect. These latter will serve as nurseries from which other trees may receive the pest. However non-destructive the scale may be for a given species of tree, the pest should not be allowed to remain. The writer has seen cottonwoods in Oklahoma badly infested with San Jose Scale, suffering apparently no ill effects from their presence. Cases of that kind should receive very careful treatment, for such trees may live for years continually furnishing insects for the fruit trees of the neighborhood. When a pest quickly destroys a tree, then that source of infestation will be naturally removed.

TREATMENT.

The San Jose Scale, through its very nature, is a difficult insect to destroy. The covering is impervious to all the weaker insecticides. Its sucking habits precludes the possibility of poisoning its food. The whole system of warfare turns upon the use of some substance that can be applied that will not injure the tree, but will corrode or destroy the scale covering. Such substances as strong lye water, crude petroleum, sulfur compounds and hydrocyanic acid gas have been used with varying success. Many experiments have been made with these various compounds but the ones giving the most satisfactory results are the sulfur compounds. Sulfur and lime, if applied during the dormant season is an effectual remedy for the Scale in Oklahoma. Trees thus treated for one or two years can be practically freed from the pest. Those trees so badly infested that portions have started to die should be removed by grubbing. A sick tree is not a profitable one and it will not pay a fruit grower to waste time in trying to restore its lost vigor.

FOOD PLANTS.

The following list has been given by Dr. L. O. Howard as plants that are affected by this insect. While this list is not complete, it gives an idea of the possibilities of this pest. While some of these plants are never killed by the pest, they may serve as sources of infestation. The insects, remaining for years in a secluded position on one of these food plants, breed continually and furnish individuals for the surrounding orchards.

ORCHARD FRUITS	NUT PLANTS	Sumac
Pear	Almond	Willow
Peach	Chestnut	Milkweed
Apple	Pecan	Catalpa
Plum	Walnut	Poplar
Cherry	ORNAMENTAL PLANTS	Maple
Persimmon	Rose	Birch
Quince	Hawthorn	Mountain Ash
Flowering Quince	Spirea	Japan Quince
SMALL FRUITS	Cotoneaster	Actinidia
Strawberry	Euonymus	Citrus Trifoliata
BUSH FRUITS	Huckleberry	Dogwood
Raspberry	Linden	Snowball
Gooseberry	Acacia	Juneberry
Grape	Elm	Loquat
Currant	Alder	Laurel
Flowering Currant		Akebia
		Osage Orange

The Author has found it also upon Cottonwood, Black Locust, Honeysuckle and American Ivy.

DESTROYING INFESTED TREES.

The mere cutting down of those trees that are badly affected will not remove the scale. The writer found several cases in El Reno, where the trees had been cut off a few inches below the surface and the sprouts coming from the old roots were as badly infested as the original tree. The scales travel below the surface, or are carried there by some other insects. Dr. Webster believes that ants may carry the young larvae to these portions of the tree. The trees should be completely grubbed out and burned.

LIME AND SULFUR SOLUTION.

The lime and sulfur solution has been tried in a series of experiments in Oklahoma with excellent results. The formula used was as follows:- Quick-Lime 15 lbs. Sulfur 15 lbs. Water 50 gals.

A large iron kettle was used for preparing the solution. (See Fig. No.2). The lime with enough water to slack it was placed in the kettle and allowed to slack. The sulfur was then added, with sufficient water to allow boiling. The boiling should be continued or about one hour, adding water from time to time to prevent caking in the bottom of the kettle. The solution passes from a yellow



Fig. 2. Iron kettle used in mixing lime sulfur wash.

to an amber color becoming also more liquid. The chemical reaction has taken place when this condition is reached and the solution is ready to be added to the spray tank. The whole solution should be made up to 50 gallons and filtered through wire gauze to remove the coarse particles that will interfere with the working of the pumps.

The solution can be boiled by live steam, and some of the large outfits in the East have a steam boiler attachment by means of which live steam is conducted to the bottom of the barrel containing the lime and sulfur. The temperature can be raised to about the boiling point and the reaction between the lime and sulfur accomplished.

APPLICATION.

This solution should be applied to the whole tree. The trees if pruned back as shown in Fig. No. 3. will be more easily sprayed and less material will be necessary. It will pay to prune quite severely. The pruning will invigorate the trees, as well as aid in the application of the insecticide. With this treatment, it must be borne in mind that no scale is killed that is not hit by the solution. After



Fig. 3. A tree properly pruned to receive spraying solution.

the trees have been sprayed they appear whitened as shown in Fig. No. 4. This gives an excellent indication for determining the thoroughness of the work. The time for applying this solution is during the dormant period of the tree. At any time between the falling of the leaves in the fall to the swelling of the buds in the spring the work may be done. Some entomologists recommend two applications a year, fall and spring, but the work this last year indicated that excellent results can be obtained by one washing and that done in the spring. Thoroughness is the secret of success, and by two applications there is less liability to leave some portions unsprayed, but there is no reason why the work cannot be well done in one spraying.

EXPERIMENTS.

A young orchard containing several kinds of fruit, was obtained near Mulhall for the experimental work. The first object was to determine the efficiency of the lime and sulfur wash for the San Jose Scale in Oklahoma. The second one was to compare this solution with an excellent white wash. This latter solution could be applied whenever the trees showed signs of needing it and if effectual would do away with the more violent lime and sulfur that must be applied during the winter.

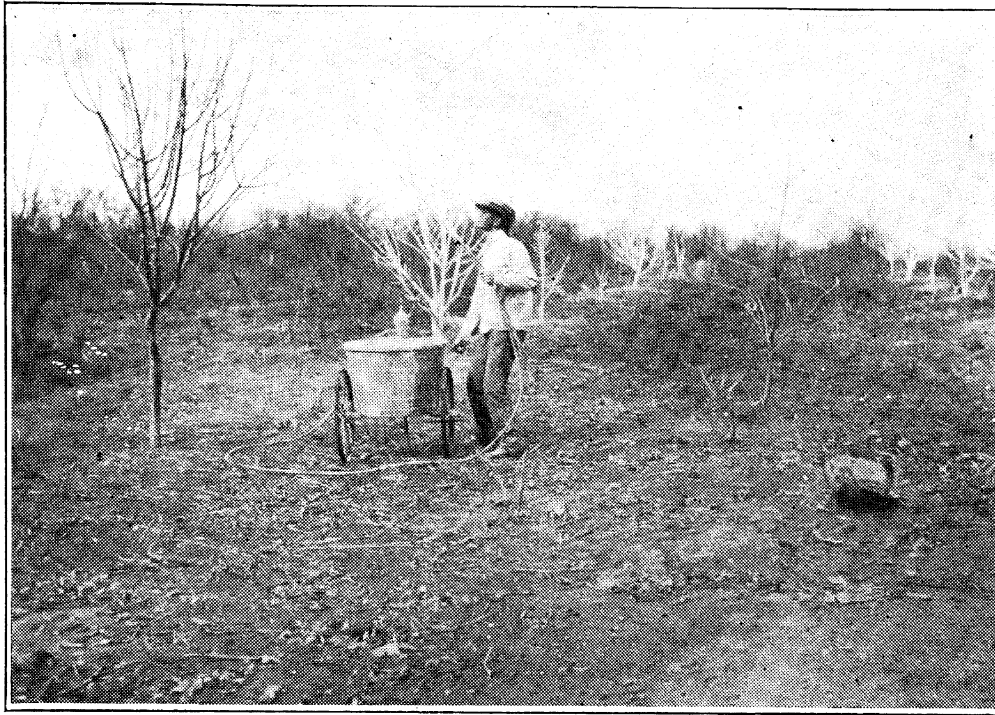


Fig. 4 Spraying orchard with Lime Sulfur solution.

THE ORCHARD PLAT.

0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	94	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	93	0	92
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	91	90	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	89

THREE ROWS OF GRAPES

88	87	86	85	84	83	82	81	80	79	78	77	76	75	74		
<i>59</i>	<i>60</i>	<i>61</i>	<i>62</i>	<i>63</i>	<i>64</i>	<i>65</i>	<i>66</i>	<i>67</i>	68	69	70	71	72	73		
	<i>58</i>	<i>57</i>	<i>56</i>	<i>55</i>	<i>54</i>	<i>53</i>	<i>52</i>	51	<i>50</i>	49	48	47	46			
	33	34	<i>35</i>	36	37	38	<i>39</i>	<i>40</i>	<i>41</i>	<i>42</i>	<i>43</i>	<i>44</i>	<i>45</i>			
	<i>32</i>	31	<i>30</i>	29	28	27	<i>26</i>	<i>25</i>	<i>24</i>	<i>23</i>	<i>22</i>	<i>21</i>	<i>20</i>			
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17

Numbers in bold face type are for trees sprayed with lime and sulfur solution.

Numbers in italics are for trees sprayed with white wash.

Numbers in regular type are for check trees unsprayed.

Table to show results of spraying.

No. of Tree	Kind	Size	Wash used	Average number of live scales per square inch.		Remarks.
				Before	After	
1	Pear	2 in.	L. S.	2	—	A live scale found only here and there.
2	"	6 "	L. S.	3	0	
3	"	5 "	L. S.	—	0	
4	"	5 "	L. S.	1	0	
5	"	6 "	L. S.	—	0	A few alive on new growth.
6	"	4 "	L. S.	—	—	
7	Plum	4 "	L. S.	11	21	On new growth, no spray here.
8	"	7 "	L. S.	3	0	On new growth.
9	"	5 "	L. S.	5	1	
10	"	6 in.	L. S.	3	0	All through the tree.
11	"	6 "	L. S.	4	—	
12	"	7 "	check	3	4	Live scales under the white wash
13	"	6 "	W. W.	5	5	
14	"	5 "	W. W.	5	8	Nov. 25 many young scales.
15	"	5 "	W. W.	4	6	
16	"	3 "	W. W.	7	9	Tree dying.
17	"	3 "	W. W.	8	3	
20	"	3 "	W. W.	15	57	Badly incrustated, tree dying.
21	"	4 "	W. W.	4	10	Incrusted, many on new growth.
22	"	5 "	W. W.	5	17	
23	"	4 "	W. W.	3	1	
24	"	4 "	W. W.	5	7	
25	"	4 "	W. W.	6	15	
26	"	7 "	check	7	3	
27	"	4 "	L. S.	6	0	
28	"	4 "	L. S.	6	0	Live ones only where not sprayed
29	"	1 "	L. S.	2	—	
30	"	sprouts	check	Bad	The	incrustated sprouts now dead.
31	Plum	sprouts	L. S.	Before spraying	completely	incrustated.
				Nov. 25 sprout dead.	Small sprouts grew this season from the stump through the infested branches but no scales were found.	
32	Cherry	1 in	not sprayed.			
33	Plum	7 "	L. S.	2	0	Live on outer branches.
34	Cherry	4 "	L. S.	—	0	
36	Peach	3 "	L. S.	0	0	
37	Cherry	7 "	L. S.	—	0	
38	Plum	4 "	L. S.	1	0	
39	Plum	6 "	check	11	10	
40	Plum	6 "	W. W.	4	8	
41	Apple	2 "	W. W.	inc.	inc.	
42	Apple	1 "	W. W.	9	inc.	
43	Apple	1 "	W. W.	—	5	
44	Apple	sprouts	W. W.	inc.	inc.	
45	Apple	1 in.	W. W.	14	inc.	
46	Peach	6 "	L. S.	8	4	
47	Apple	2 "	L. S.	inc.	dead	
48	Apple	2 "	L. S.	21	4	
49	Apple	3 "	L. S.	9	3	

Table to show results of spraying.

No. of Tree	Kind	Size	Wash Used	Average number of scales per square inch.		Remarks
				Before	After	
51	Apple	5 in.	L. S.	inc.	3	Live ones on outer branches.
52	"	3 "	check	—	1	
53	"	2 "	W. W.	inc.	inc.	dead
54	"	4 "	W. W.	4		
55	"	2 "	W. W.	—	2	
56	"	sprouts	W. W.	—	1	
57	"	4 in.	W. W.	1	1	
58	"	2 "	W. W.	—	1	
59	"	3 "	W. W.	—	4	
60	"	3 "	W. W.	—	15	
61	"	1 "	W. W.	1	2	
62	"	1 "	W. W.	—	5	
63	"	3 "	w. w.	—	5	
64	"	1 "	w. w.	—	12	
65	"	2 "	w. w.	2	inc.	
66	"	2 "	w. w.	1	3	
67	"	3 "	check	4	3	
68	"	2 "	L. S.	1	—	
69	"	3 "	L. S.	1	.2	Live ones on outer branches.
70	"	2 "	L. S.	2	.2	Live ones on outer branches.
71	"	2 "	L. S.	3	0	Few live ones on new growth.
72	"	3 "	L. S.	2	—	Few on outer branches.
73	"	2 "	L. S.	2	—	Few live ones on outer branches.
74	Peach	6 "	L. S.	11	1	
75	Apple	2 "	L. S.	18	3	
76	"	1 "	L. S.	0	0	
77	"	2 "	L. S.	—	—	One live scale found.
78	"	2 "	L. S.	—	—	
79	"	2 "	L. S.	3	0	
80	"	4 "	check	4	1	
81	"	2 "	W. W.	0	—	
82	"	1 "	w. w.	0	—	
83	"	3 "	w. w.	3	4	
85	"	1 "	w. w.	0	—	
86	"	4 "	w. w.	3	18	
87	"	1 "	w. w.	—	9	
89	"	2 "	L. S.	—	0	
90	"	1 "	L. S.	inc.	0	Patches of old scale still present but all dead. Tree healthy.
91	"	3 "	L. S.	2	—	Few live ones on new growth.
92	"	5 "	L. S.	2	—	
93	"	1 "	L. S.	2	1	
94	"	1 "	L. S.	—	0	

In the above table L. S. stands for Lime Sulfur. "w. w". for Whitewash; "—" means less than one scale per square inch. "inc". means the tree was completely incrustated with scale.

In the chart of the orchard those trees marked 0 were not infested with San Jose Scale.

In making the count, areas of a square inch each were mapped out on the tree and the scales on these areas counted with a small hand lense. The averages were taken from forty or fifty areas counted on each tree. Dead and live scales were counted and then an examination made to determine what per cent of the scales were alive.

The results indicate the value of lime and sulfur for the San Jose Scale. White wash had no value as a scale destroyer.

The white wash used was made as follows:

1-2 bushel of quick-lime,
Boiling water to cover,
1 lb. salt,
1-2 lb. zinc sulfate,

The zinc sulfate and salt were dissolved in water before adding. When the mixture was cool it was diluted to the thickness of cream by adding water.

This wash was sprayed upon the trees with the hand pump. See Fig. No. 4.

The first washing was done March 16, 1907 before the trees had begun to leaf out. At this time lime and sulfur and the first application of white-wash were applied. The trees received no further application of the lime and sulfur. The trees that received white-wash were watched and a second application made when the effects of the first had disappeared. The second white-washing was made July 7, 1907.

The lime sulfur wash remained on the trees throughout the summer in quantities large enough to be easily seen by the casual observer.

SUMMER TREATMENT.

Trees infested may be treated during the summer with solutions that will destroy the young scale insects, and which will retard and interfere with the breeding of old scales. Such treatments are not designed to eradicate the scale, nor will they prove successful unless followed by the winter treatment with lime and sulfur. The treatment will prevent the spread of the pest that naturally would result if it was not given and has value from that standpoint. Whale oil soap was found to be the best solution to use during the summer, and is made as follows:

Dissolve one pound of whale-oil soap in four gallons of hot water. Apply this to every portion of the tree, either with a spray pump or by hand, the object being to hit every scale on the tree. This washing should be repeated once in every three weeks until

the leaves fall, after which the lime and sulfur can be applied. The combining of the summer and winter treatments will solve the scale problem very satisfactorily for the first year. After the first year, an application of lime and sulfur each winter for a season or so will completely subjugate this pest.

FUMIGATION.

Fumigation is a process of subjecting insects to the influence of some gas that will quickly kill them. Such gas can be generated by mixing Sulfuric acid and Potassium cyanide together. The gas given off is deadly to all animal life and has dangers for the operator if carelessly handled. The breathing of the fumes may result in immediate death. The strength of the fumes necessary to destroy



Fig. 5. A small box type of fumigatory for nursery stock insect life is not great enough to injure plants or food products, and can be used if correctly handled for destroying the San Jose Scale upon dormant trees. In order to accomplish this in an orchard a large air-tight canvass must be placed over the trees, and the gas generated in the interior. This makes the operation too expensive for the general treatment of orchards, altho it is used to a considerable extent in California where the trees are valuable enough to pay for the costly treatment. For nursery stock, however, this method can be very economically used. A fumigation house or box can be

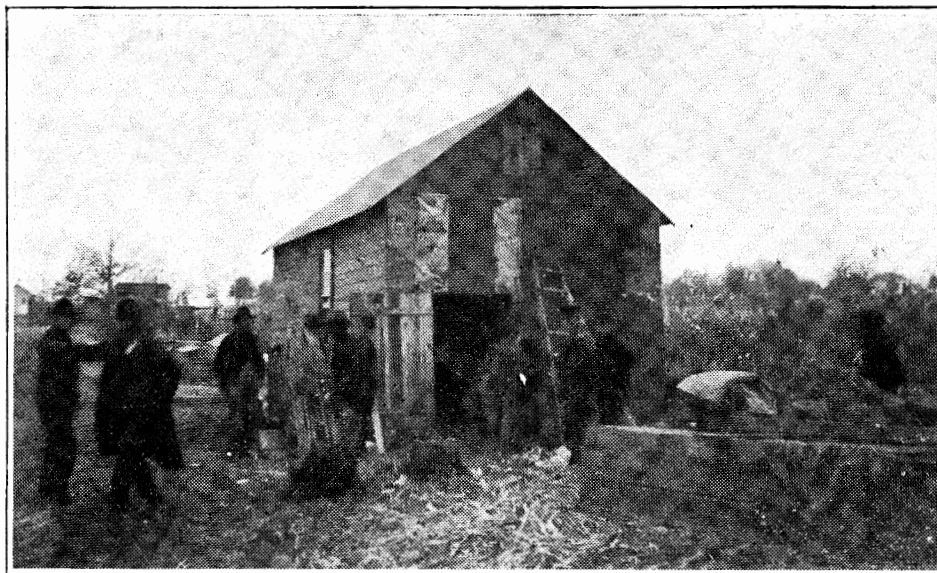


Fig. 6. A fumigatory for large nurseries.

easily prepared, and the stock taken in and subjected to the treatment. Figs. 5 and 6 show two types of fumigatories used by nurserymen. The small box is gas tight and a limited amount of stock can be treated successfully. The larger house will hold a larger quantity of nursery stock and is necessary for the larger nurseries.

METHOD OF FUMIGATION.

The fumigatory is filled by loosely piling the stock in the same, leaving an open space in the center for the fumigating materials. A large earthen jar is used to contain the chemicals. Metal or wood will not do, on account of the action of the solution on these substances. Determine the space in the house or box in cubic feet. The amount of chemicals necessary for a room is estimated in terms of potassium cyanide per cubic foot of space enclosed. The amount of potassium cyanide should not be more than 0.0088 oz. per cubic foot for any kind of nursery stock. The amount of sulfuric acid used is one-half more than cyanide and the water one-half more than the amount of acid used.

For example, if the cubic space was found to be 1161 cubic feet, we would use $.0088 \times 1161 = 10.21$ ounces. To discard fractions we call it 10 ounces of cyanide. One-half as much more of Sulfuric acid would give us 15 oz. (liquid) of Sulfuric acid. Adding one-half as much more of water as acid we would have 22 1-2 oz. water. The

water is placed in the earthen jar and the sulfuric acid, which should be pure, is added slowly to the water. The cyanide of potassium, 99% pure, is placed in a paper sack, and dropped into the water and acid. The operator should get out of the room at once and close the same tightly. The acid will immediately penetrate the sack and the union between the chemicals will take place, giving off the deadly hydrocyanic acid gas. Allow the gas to remain in the fumigatory for forty minutes, at the end of which time the doors and windows should be thrown open and the building allowed to air for 15 or 20 minutes before any one is allowed to enter. At the end of this time the stock can be removed and the fumigatory refilled for the second fumigation. A few points to remember in fumigating nursery stock have been given by W. G. Johnson in his little book on fumigation, are not out of place here.

1. Never use the gas stronger than .0088 ounces of potassium cyanide per cubic foot on any kind of nursery stock.
2. Never leave the trees exposed to the gas longer than one hour. Thirty to forty minutes is sufficient.
3. Never fumigate trees, especially peach, a second time.
4. Never fumigate trees in a car, box or cellar after they are packed. The gas will not penetrate to the interior.
5. Never fumigate trees when they are drenching wet. They may be moist, even quite damp.
6. Never puddle the roots of trees before they are fumigated.
7. Do not fumigate cedars and evergreen trees.
8. Do not fumigate trees until the wood is well matured and the buds thoroughly dormant.
9. Never fumigate June buds and peach under three feet with gas stronger than .0063 ounces of cyanide per cubic foot. Better use .0056 ounces.
10. Never fumigate buds, grafts, or scions with gas stronger than .0056 ounces per cubic foot.
11. Do not leave the potassium cyanide in reach of children—Mark it "POISON."
12. Never take the cyanide out of the can unless you are ready to use it.
13. Do not leave the door of the fumigating room open a moment after the cyanide has been dropped in the acid.
14. Never allow a person to go near or open the door when fumigating trees.
15. Never allow anybody to enter a room under ten or fifteen minutes after the doors and ventilators are open.
16. Place the residue left in the jar, after fumigation, in a hole

and cover with a foot of earth.

17. Never put sulfuric acid in tin or iron vessels; it will eat them up.

Fumigation will kill all animal life on the trees, such as woolly aphids and other insects, so that fumigated trees are to be desired from that point. The gas will not destroy fungus diseases of stock, such as crown gall or root knot.

NATURAL ENEMIES OF THE SAN JOSE SCALE

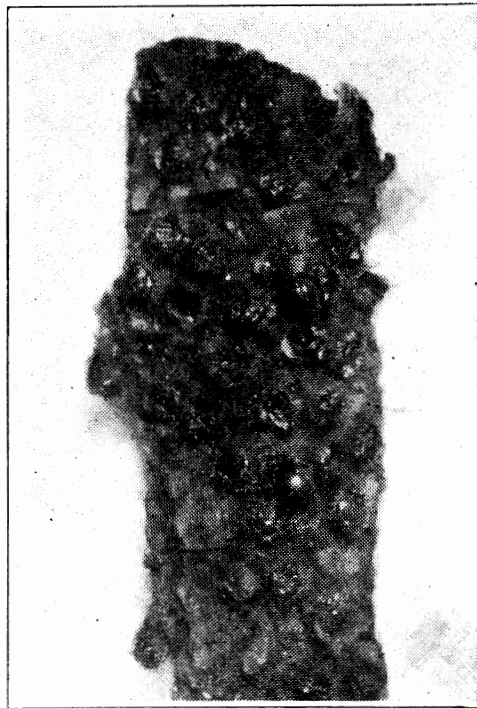
There are few natural enemies of this pest. In its native home in China, the insect is held in check by a native lady-bug, but in the U. S. it seems to be free from enemies, and thrives beyond all bounds. There is a native lady-bug here, however, that should be encouraged to live in the orchard since it is efficient in destroying a limited number of scale insects. This is the beautiful black lady-bug with two bright red spots, (*Chilocorus bivulnerus*). Fig. 7 shows the larval skins and adults of this insect as they may be seen upon trees infested with scale.

These natural enemies cannot be relied upon to hold our scale in check, but should be protected for the good they will do.

SAN JOSE SCALE VS.

THE NURSERYMAN.

The San Jose Scale is spread naturally for a limited distance by such agents as wind, birds, man and insects such as flies, bees, grasshoppers and June bugs, but this distribution could not proceed far even under favorable circumstances. The young only are thus transportable and the distribution over wide areas must come by other means, while the insect is in the quiescent state. Nursery stock offers the greatest opportunity for wide dispersal. Infested



stock may be shipped over wide areas, and each tree then becomes a focus from which the insects scatter to the immediate surroundings. In this way the scale has entered Oklahoma. It is imperative, there-

Fig. 7. San Jose Scale. *Chilocorus bivulnerus* Muls. (Lady birds that feed on San Jose Scale.) (Original.)

fore, that stringent measures be taken to prevent the farther introduction of this pest into our state. It is much easier to exclude the insect than it is to destroy it after it has made its appearance. Upon this suggestion the legislature of Oklahoma passed the aforementioned nursery inspection laws. These laws were designed not only to prevent the importation of scale into Oklahoma, but to prevent the dissemination of the insect through the state by nurseries of the State. Under this law, the following insects and fungus diseases are considered injurious;

- San Jose Scale (*Aspidiotus perniciosus*).
- New Peach Scale (*Diaspis Amygdali*).
- Black Knot (*Plowrightia morbosa*).
- Crown gall (*Dendrophagus globosus*).
- Peach Yellows.
- Peach and Plum Rosette.
- Woolly Aphis (*Schizoneura Langeria*).
- Mexican Cotton-Boll Weevil (*Anthonomus grandis*).

When San Jose Scale is found in a nursery in Oklahoma, all infested stock must be burned. If the scale is found in the immediate neighborhood all stock must be fumigated or certificate will be withheld.

This law provides for an annual inspection of all nursery stock in Oklahoma, and an inspection of the trees in the immediate neighborhood for the purpose of detecting the presence of this insect. As a result of this law the nursery inspector has located San Jose in the above mentioned districts, and the nurserymen in those localities have been required to fumigate all their stock. The scale has not been found in any of the stock belonging to the nurserymen. This regulation has prevented the dissemination of the scale from those localities where it is at present, but has not operated to compel the destruction of the scale in those localities. Whereas the law compels the nurserymen to resort to drastic measures to insure against the spread of the scale, it does not reach the fruit grower, whose trees are infested, and which infestation becomes a source of trouble for the nurserymen. The law should be so amended that San Jose Scale could be ordered destroyed wherever found in Oklahoma. The regulations regarding the nurserymen should not be relaxed, but the whole law supplemented so that these foci of infestation could be removed.

The following are a few provisions found in our law:

"All nursery stock, including fruit trees, strawberry plants, vines, ornamental trees and shrubs and field grown roses, shipped into Oklahoma from any other state or territory should be plainly labeled or tagged with a copy of the certificate of inspection signed by the

state entomologist or duly authorized official of the state or territory in which such nursery stock shall have been grown, duly certified over the facsimile signature of the secretary of the Oklahoma Board of Agriculture. All consignments of nursery stock not so labeled or tagged shall be liable to seizure, confiscation and destruction by the duly authorized entomologist or inspector of the Board of Agriculture. To insure the safety of foreign stock the inspector or his assistant shall have authority to inspect any shipment of nursery stock at any station in this state, and shall have authority to stop any nursery stock when in transit, for the purpose of inspecting the same, regardless of whether such stock shall bear a certificate of inspection or not. The inspector shall have authority to seize, condemn and destroy any nursery stock infested with San Jose Scale or other seriously injurious insect or disease, found within the confines of this state. Transportation companies and their agents shall immediately notify the Secretary of the Board of Agriculture, when by oversight, negligence or otherwise, any shipment of nursery stock without a proper certificate attached, shall arrive at any station in this state and it shall be the duty of the secretary to proceed as speedily as possible by himself or a duly authorized inspector, to investigate and dispose of such shipment. All nursery stock grown in states and territories where there is no nursery inspection law shall be inspected by the entomologist of the Board of Agriculture before the same can be delivered to the assignee." These laws are designed for the protection of the fruit industry of our state and should receive the hearty support of all those having the welfare of our state at heart.

The laws upon the statute books of some other states are even more drastic than our laws regulating this pest. It is not necessary to enumerate all these laws. The San Jose Scale is an insect to be feared, wherever found, and especially in Oklahoma.

The following states have rigid laws regarding the importation of nursery stock:

West Virginia x	Wisconsin	Canada x
Alabama	Indiana	Wyoming
Arkansas	Iowa	Minnesota
California	Kansas	Missouri
Colorado	Kentucky	Montana x
Connecticut x	Louisiana	Nevada
Delaware	Maine	New Hampshire
Georgia	Maryland	New Jersey
Idaho x	Massachusetts	North Carolina

Illinois	Michigan x	Ohio
Pennsylvania x	Rhode Island	Oregon
South Dakota	Tennessee	South Carolina x
Utah x	Virginia	Texas x
Washington		

All the above states require shipments to be accompanied by a certificate of inspection, but in addition to such certificate, the states marked with "x" requires all shipments to be accompanied by a certificate of fumigation.

Wyoming and Canada require all stock to be addressed so that it will reach one of several designated quarantine stations where it is unpacked, inspected and fumigated.

SUMMARY.

1. San Jose Scale can be controlled in Oklahoma by spraying in the winter with Lime and Sulfur.
2. Fumigation with hydrocyanic acid gas will insure against this insect when nursery stock comes from infested districts.
3. Laws should be enacted to force owners of trees infested with San Jose Scale to destroy or spray at the discretion of an Entomologist.
4. Foreign nursery stock should be closely watched to insure against importation of this pest.
5. The legislation of other states indicates the seriousness of this pest.